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Introduction

A thick body of dacitic volcanic rock covers large areas in the vicinity of Globe, Miami, and Superior, Arizona. During the writer's assignment to geologic mapping in this area, as part of the Globe-Miami project of the U. S. Geological Survey, he became interested in the origin of these rocks. This study is the result of that interest.

Within the last thirty years, sheets of silicic volcanic rock with distinctive characteristics, similar to those of the dacite body near Superior and Globe, have been recognized in the western United States and in other parts of the world. These rock bodies differ from lava flows on the one hand and air-fall tuffs on the other, yet possess certain features common to both. In the literature of English speaking countries they have generally been called "welded tuffs" or ignimbrites". Explanations of their origin have required modifications of long-standing concepts of volcanism, and many recent studies have been concerned with the description and origin of these rocks. All but the most recent are listed in Cook's "Ignimbrite Bibliography" (1958). Several recent papers give excellent reviews of the development of scientific thinking on this problem; among these are those by Martin (1959), Mehnert (1960), Smith (1960), and Cook (1960). Each of these articles provides a good insight into the current thinking and the unsolved problems of these most interesting deposits. Deserving of special mention, perhaps, is Smith's review article in which the mode of eruption; recognition of units, size and characteristics of deposits, source areas, origin of the magma, and other problems are treated.

The chief purpose of this paper is to describe the dacitic ash flow deposit near Superior, Globe, and Miami, Arizona. In addition, certain ideas on the origin of the deposit are advanced, and criteria for structural interpretation within the seemingly uniform part of the sheet are proposed.

Field work

The Globe-Miami project of the U. S. Geological Survey has included detailed geologic mapping of five 7½-minute quadrangles: Globe, Inspiration, Pinal Ranch, Haunted Canyon, and Superior. These quadrangles lie between 110°45' and 117°7½' west longitude and 33°15' and 33°30' north latitude, and their locations are indicated on figure 1. Nels F. Peterson has been in charge of the project since it began in 1943. Several reports on the geology of the area have been published, and others are in press. Those describing the dacite and showing its distribution include: N. F. Peterson, Gilbert, and Quick, 1951, p. 42-43; N. F. Peterson, 1954; D. W. Peterson, 1960; N. F. Peterson, in press (1) and (2). The present paper is based chiefly on the writer's mapping and studies in the Haunted Canyon and Superior quadrangles. N. F. Peterson and others have done most of the geologic mapping in the three remaining quadrangles, though the writer mapped small areas in the Inspiration and Pinal Ranch quadrangles and has supplemented the work by brief studies of the dacite in scattered localities in each of the quadrangles. The study has been made at intervals from 1952 to 1960. Approximately eighteen months of the time spent in the field during this period has been devoted to the dacite and closely related problems.

Previous work

The dacite was first studied in the Globe 15-minute quadrangle by Ransome (1903, p. 88-95) who identified it as a lava flow. He recognized three distinct phases: tuff at the base, vitrophyre, and thick dacitic flows. Several of Ransome's later papers contain descriptions of the dacite, and some of his later maps show additional areas covered by dacite, but these reports use essentially the same description as the earliest paper (Ransome,).

Short and others (194 , p.) described the dacite near Superior as alternating lava flows and tuff deposits. N. P. Peterson, in his studies between 1943 and 1955, deduced that a lava as silicic as this dacite would be erupted as relatively short, thick flows, with contorted flow structures, whereas the deposit actually covers hundreds of square miles and the flow-like structures are uniformly flat-lying or gently tilted. He concluded that ash flows of a glowing-avalanche type were the most probable manner of eruption of the dacite (N. P. Peterson, in press (1)). C. S. Ross (1955, p. 431) has stated that the dacite is welded tuff.

Terminology

In new fields of investigation it seems inevitable that a certain amount of confusion of terminology develops. Different investigators, working independently, may introduce different names for the same feature, or they may use a single term in different senses. The full range of meaning, or the limitations of a newly coined term, may not be realized until after it has been used in different ways by several different workers. Each of these difficulties are well illustrated by

the general subject embraced by the terms welded tuff, ignimbrite, ash flow, and other related names. The difficulties can be minimized if the terms to be used are clearly defined and used accordingly by each author.

R. L. Smith (1960, p. 800-801) has clearly defined a set of terms that he has found applicable in working with and describing these deposits, and in an effort toward attaining a uniform nomenclature, the writer intends to follow Smith's terminology as nearly as possible. Brief definitions of Smith's terms are repeated here, but the reader should refer to Smith's paper for their full implications.

Ash flow: The basic unit of ash-flow deposits; the deposit resulting from the passage of one nuee ardente.

Ash flow sheet: Any unspecified sheetlike unit or group of units considered to be of ash-flow origin.

Welded ash flow: An ash flow in which welding has produced a conspicuous zonal pattern.

Welded tuff: A rock or rock body in which vitric particles have some degree of cohesion by reason of having been hot and viscous at the time of their emplacement.

Welded tuff sheet: A sheetlike body of rock containing conspicuous welded tuff.

Cooling unit: A single or multiple ash-flow deposit that can be shown to have undergone continuous cooling.

Simple cooling unit: An ash flow or sequence of ash flows that has had an essentially uninterrupted cooling history.

Compound cooling unit: One that shows departures in expectable zonation and other properties which result from simple cooling, because the intervals between ash flows were too great for readjustment to a single-unit cooling gradient.

Composite sheet: A cooling-unit complex that grades from one cooling unit into two or more cooling units.

Before Smith's definition of "ash flow" can be understood, it is essential to know precisely what he means by a "nuee ardente". Briefly, he emphasizes the original observations that a nuee ardente has two parts, a basal avalanche that contains the bulk of the erupted material, and an overriding cloud of expanding gas and dust (Smith, 1960, p. 802-804). Although a nuee ardente is both a type of eruption and a agent of transport, Smith emphasizes its nuee as an agent of transport of material from the vent to its final resting place.

Ash-flow field: Deposits of pyroclastic rocks consisting preponderantly of ash flows, which are related to some specific unit of area.

The following summary is made to show how this terminology applies to the dacite near Superior, Miami, and Globe. The dacite is an "ash-flow sheet", made up of an undetermined number of separate "ash flows" that in most places cannot be individually recognized. Since an appreciable portion of the sheet is welded, it would be misleading to apply the name "welded tuff sheet" to the deposit, but since a large part of it is welded perhaps it would not be entirely inaccurate. Individual ash flows are recognized only with difficulty, and where distinguished they do not show individual zoning patterns, but lie

entirely within a single zone related to the entire cooling unit. Therefore, the term "welded ash flow" does not seem to apply to this deposit.

It will be shown that in most places the dacite comprises a "simple cooling unit". It locally grades into a "compound cooling unit", but the departure from simple cooling is not great. It could be called a "composite sheet" because it shows both simple and compound cooling, but since the departure from simple cooling is small, a more accurate idea of the deposit's total character is rendered by thinking of it as a simple cooling unit.

The deposit considered in this study does not in itself constitute an "ash-flow field". But the larger volcanic field of which this deposit is a part, that extends from the Superstition Mountains southeast to Roy and northeast to the Salt River 15 miles east of Roosevelt Lake, can probably be regarded as an "ash-flow field".

The writer must here clarify and explain his use of the term "dacite". In a strict sense, dacite is a volcanic rock with appreciable quartz phenocrysts and with its feldspar phenocrysts mostly plagioclase, and its principal use in this paper will be as a rock name. Because "dacite" has long been used in the literature as the name for the dacitic body of rock near Superior, Globe, and Miami, Arizona (Ransome, 1903, 1919, 1923, Short and others, 1943; N. P. Peterson, 1951, 1954), and because it is well established in local usage, it has been found convenient in this report to refer to this particular rock unit as "dacite". As such it will alternate with "ash-flow sheet" and "cooling unit". "Dacite"

will be used when referring to this particular deposit, "ash-flow sheet" is used when referring to the general type of deposit to which it belongs, and "cooling unit" is used when emphasizing its cooling history. Some persons object to applying compositional rock names to rock units, apparently because of potential confusion of intended meaning. However the writer feels that the context removes the meaning clear, and that less confusion will result if "dacite" is applied in the same sense as in the previous literature on the district.

Field description of the ash flow sheet

Distribution, area, thickness, and volume of the deposit

Dacitic ash flow deposits originally covered an area of at least 400 square miles in the Globe-Superior area, but erosion has reduced the present outcrop area to about 100 square miles (fig. 1). It is possible that the deposits originally covered a much greater area, perhaps 1,500 square miles, but correlations have not been established with similar appearing rocks that lie to the northeast in the Superstition Mountains and to the west and southwest.

The largest continuous area now covered by the ash flows lies northeast of a line between Superior and Ray, and extends eastward to the Dry Wash Fork of Mineral Creek, and northward to Pioneer Gulch and Weed Creek. Other large remnants of the same lie between Haunted Canyon and the West Fork of Pinto Creek, along Pinto Creek near Gold Gulch, and in the area around Webster Mountain, upper Sycamore Canyon, and Ray Peaks. Smaller patches lie north of Globe and Miami, and others are scattered through the area shown in figure 1. Part of a large ash flow remnant crowns the northwest corner of the map of figure 1.

Thickness of the ash flow sheet depends both on irregularities of the surface at the time of eruption and on subsequent erosion. Because of the underlying relief, original thickness was variable, furthermore, the eroded upper surfaces prohibit completely determining the range of original thickness. In a few places, however, rocks lying close to the original upper part of the unit are preserved, and original thickness can be estimated. The ash flow sheet is thickest just east of Superior where it reaches about 1,800 feet. In each of the larger areas of outcrop,

thicknesses of over 1,000 feet are common, and it is estimated that the average thickness of the sheet was about 500 feet.

The trends of variation in thickness of the ash flow sheet can be only roughly indicated because of post volcanic deformation and erosion, and scanty subsurface information. The large body of dacite east of Superior appears to be quite thick over most of its extent, and drill holes in Devil's Canyon and near the J I Ranch show it exceeds 1,5000 feet. It becomes thinner toward the southeast, and is about 800 feet thick near the south border of the Superior quadrangle. On Sawtooth Ridge the dacite is about 1,300 feet in thickness. Eastward from Sawtooth Ridge the thickness fluctuates, but becomes progressively thinner; on JK Mountain it is 400 feet, on Webster Mountain about 500 feet, and on Sleeping Beauty about 300 feet. It is likely that the outcrop east of Globe is not much thinner than it was originally, and it is now about 160 feet in thickness; this suggests that this outcrop is relatively near the eastward margin of the ash flow. Data on the thickness variations outside the mapped area are not available.

If the deposit originally covered 400 square miles, and had an average thickness of 500 feet, its volume would have been 40 cubic miles, or 115 cubic kilometers.

Zoning of the ash flow sheet

Introduction

In most areas the ash flows formly blocky to rounded outcrops intersected by a distinct joint pattern. In areas of gentle relief, the ground surface is strewn with boulders that measure up to tens of feet across. On steeper slopes the rock forms ledges, and in rugged topography it forms ridges, peaks, and cliffs.

Five separate zones can be recognized within the ash flow deposit; distinction between them is based on differences in the character of the groundmass. The zones are, from bottom to top: (1) poorly to moderately consolidated, non-welded dacite tuff; grades upward to (2) streaky to uniform, firmly welded dacite tuff, vitrophyric, with groundmass of black glass; (3) firmly welded dacite tuff, brownish orange aphanitic groundmass; (4) firmly welded dacite tuff, pinkish gray aphanitic groundmass; (5) moderately to non-welded dacite tuff, light gray to white aphanitic groundmass. These zones will be indicated briefly as: (1) basal tuff, (2) vitrophyre, (3) brown zone, (4) gray zone, (5) white zone. The basal tuff grades upward into vitrophyre, but generally the contact between vitrophyre and the brown zone is fairly sharp. The brown zone grades upward into the gray zone, and the gray zone grades into the white zone; and only in a few places is the boundary between the upper three zones distinct.

The five zones have certain features in common. Each is porphyritic with a similar phenocryst assemblage; in hand specimen phenocrysts can be identified as feldspar, quartz, biotite, accessory magnetite, and lesser amounts of hornblende and sphene. The phenocrysts comprise from one-fourth to nearly one-half the volume of the rock. They range in size from barely discernible with the hand lens up to about 3 mm, and most are one-half to 1mm in diameter.

Lithic inclusions are common in all the zones, and locally they are abundant. Most are angular chips a fraction of an inch in diameter, but they range in size up to several inches across, and scattered boulders up to several feet in diameter have been observed. On the average, inclusions comprise 2 to 4 percent of the volume of the rock, but locally they reach 15 to 20 percent. The most common inclusions are rhyolite, probably derived from the earlier volcanic rocks; other common inclusions are diabase, quartzite, limestone, schist, and granular igneous rocks, all of which crop out in the surrounding area.

Basal tuff

At every locality where the base of the ash flow sheet is exposed, it is comprised of non-welded crystal tuff; none of the overlying units have been observed in depositional contact with older rocks. This tuff is poorly to moderately indurated, and weathers to gentle, subdued slopes. It commonly is covered by talus from the overlying, more resistant rocks. It is generally non-bedded, though in some places it consists of bedded lenses or layers of tuff that may be mixed with clastic sediments. Both weathered and fresh surfaces are light gray to white in color, and they

may grade to shades of yellowish gray and moderate red. The basal tuff ranges from 2 to over 100 feet in thickness, and averages between 10 and 20 feet.

In the most common variety of tuff, the phenocrysts lie in a light colored, powdery matrix whose texture is generally quite uniform. The rock may contain variable amounts of pumice lapilli and blocks, ranging from a fraction of an inch up to several inches in diameter. In some places the uniform texture and structure gives way to a heterogeneous mixture of abundant lithic inclusions, assorted pumice lumps, and phenocrysts in the fine powdery matrix.

Constituents of the lower part of the basal tuff are randomly oriented, but upward the pumice tends to be flattened. The tuff becomes more firmly consolidated upward, specific gravity increases, and streaks of black glass appear, 1 mm to 10 mm in length, which upward become more abundant. These changes mark the gradational transition from tuff to vitrophyre, which in some places is accomplished within one or two feet, and in other places extends over a stratigraphic interval of 30 to 40 feet.

Vitrophyre

A layer of porphyritic glass lies between the basal tuff and the overlying lithified units, and it apparently extends continuously over the entire area of the ash flow sheet. The vitrophyre is generally a firm, compact rock, resistant to weathering, and commonly stands out as a ledge or as distinct outcrops above the basal tuff. In other places, however, it crumbles easily and may be covered by debris from above. It weathers to a dark gray or dark brown color, and it generally

contrasts distinctly with the lighter colored rocks above and below. The fresh surface typically is shining black mottled with light colored phenocrysts (fig.), but it varies to black streaked with abundant brown lenses. The vitrophyre ranges from 2 to 80 feet in thickness, and averages between 5 and 25 feet.

The vitrophyre typically consists of phenocrysts set in a matrix of uniform, black glass. Megascopically the glass appears to be massive and uniform, but the microscope reveals the layered and deformed fragmental textures that are characteristic of very firmly welded tuffs. In some places the glass shows perlitic structure. Gradational between the massive appearing vitrophyre and the underlying tuff are streaky phases of vitrophyre, consisting of alternating, irregular layers and lenses of black glass and brown to gray aphanitic material. In many places, especially where it is thin, the vitrophyre consists entirely of this streaky phase.

The vitrophyre and the brown zone generally contain more lithic inclusions than the other zones. Precise counts have not been made, but it is estimated that most of the vitrophyre contains 5 to 10 percent xenoliths.

Small spherical nodules are common in some localities in the vitrophyre; they contain the same assemblage of phenocrysts set in a brown, aphanitic groundmass. The nodule boundaries are sharp and distinct; they generally are more resistant than the surrounding glass and stand out as bumps on the weathered surface. Their centers are generally occupied by a dusty powder, which is immediately removed by

weathering when exposed at the surface, so weathered cross sections of the nodules appear to be hollow. Some nodules have only a thin rim or none at all, and are occupied largely or entirely by the powdery material. The nodules commonly range from a fraction of an inch to about 4 inches in diameter, but some reach several feet in diameter. In most places they comprise only a fraction of a percent of the volume of the rock, but locally they increase in abundance to several percent.

In a few places the vitrophyre is cut by well developed columnar joints. These joints define individual polygonal columns, a foot or less in diameter and 10 to 40 feet or more in height. A single joint surface lies between two columns only, and each joint is intersected by other similar joints at the corners of the polygons. This type of jointing is typical of basaltic and andesitic lavas, and has also been observed in many ash flows; it is generally considered to have developed due to contraction of the rock during cooling. With one exception, in this area columnar jointing has been observed only in the vitrophyre unit. It does not extend up into the brown phase, and gradually dies out downward into the underlying partly welded tuff.

Over most of the area, basal tuff grades upward into a single vitrophyre layer, which in turn is overlain by the brown phase of dacite. In some areas, however, above the basal tuff a lower vitrophyre layer grades upward into an intervening layer of tuff, which in turn grades upward into a second vitrophyre layer. The intervening tuff pinches and swells irregularly, and reaches a maximum thickness of about 15 feet. The lower vitrophyre is generally only a few feet in thickness, but the upper vitrophyre ranges from a few feet to several tens of feet in thickness. Exposures studied have been inadequate to definitely establish

the lateral extent of any particular layer of intervening tuff, but some may extend for several hundred feet, and others may reach even farther. In the area from King's Crown Peak southward to beyond Queen Creek, nearly every complete exposure of the vitrophyre contains a layer of tuff between upper and lower vitrophyre. An intervening tuff has also been noted along the west boundary of the dacite between Haunted Canyon and the West Fork of Pinto Creek, particularly near Rock Creek and on Sawtooth Ridge. At the east end of this body, on the south flank of Government Hill, three distinct layers of vitrophyre are separated by partly welded tuff.

The vitrophyre's upper contact with the brown phase of dacite is generally not exposed. The contact is apparently abrupt, for typical vitrophyre commonly lies within two or three feet of lithic dacite, but the actual contact in most places is persistently hidden. In a few places, incomplete exposures reveal a crumbly, partly glassy and partly lithoidal rock at this contact. Near the south end of Devil's Canyon, however, this contact is well exposed, and it consists of a crumbable layer of rounded boulders 1 to 3 feet in diameter. The layer is from 2 to 8 feet in thickness; it persists over a lateral distance of more than a mile without interruption, and continues continuous on intermediate distances. The apparent boulders are composed of rock identical to the brown phase of the dacite, and the material between them is altered, crumbly, devitrified glass. The apparent boulders are probably some type of devitrification nodule that developed in place due to gas activity.

Brown zone

In most areas, the lithified dacite immediately above the vitrophyre has a distinct brownish orange color, and for convenience it is designated as the brown zone of the dacite. It generally is hard, flinty, and resistant to weathering, and stands as steep slopes and ledges, though locally it is soft and non-resistant. It weathers to shades of brown and grayish brown, and weathered surfaces are commonly not distinguishable from the overlying white. The typical fresh surface is a bright brownish orange, but it varies to other shades of brown and grayish brown. Because of the indefinite upper boundary, it is not possible to state precise thickness measurements, but in general its approximate range is from 20 to 200 feet. In some places it may reach 300 feet in thickness, and it pinches out or is poorly defined where the ash flow sheet is thin.

The brown zone consists of phenocrysts set in a dense, aphanitic, brownish orange matrix. In some places its texture appears almost massive and uniform, but in most places the hand lens reveals a discontinuously layered or foliated texture, formed by flattening of volcanic fragments. Although the microscope shows that much of the matrix is glassy, it is partly devitrified, and the aspect of the rock is distinctly stony or lithoidal.

Like the vitrophyre, the brown zone commonly contains more lithic fragments than the other zones. Lithic fragments commonly comprise about one-tenth of the rock, and locally they reach as much as a fourth. The abundant lithic fragments seem to occur in poorly-defined pockets that are irregular in size, shape, and thickness. Quartz is the zone their abundance decreases. A possible explanation for the concentration

of lithic fragments in the vitrophyre and brown zones is that the vents were "clearing their throats" during the earlier phases of the eruption.

No definite upper limit to the brown zone can be established, for the change from brown to the overlying gray is completely gradational. Megascopically the transition consists of an increasing darkness in the color of the brown lenticles, and the gradual appearance of light colored streaks parallel to the foliated structure. Distinctly brownish lenticles progressively diminish upward, but persist far up into the gray zone. Where individual sheets were mapped east of Superior, placement of the contact between the brown and gray zones was largely subjective because of the gradational transition.

Gray zone

The lithoidal dacite that generally comprises the bulk of the ash flow sheet is a pinkish gray, firmly welded tuff. It is a hard, resistant rock, weathered surfaces are rough, and it commonly stands as steep, rugged slopes topped by ridges and peaks. The pattern of outcrop is commonly controlled by a pervasive system of nearly vertical joints that is apparently tectonic rather than due to cooling. The joint system is crossed by a crudely developed, but distinct, layer-like structure, generally nearly horizontal. This structure is apparently caused by parting parallel to the flattened constituents. The rock weathers to shades of brownish gray and pinkish gray, and weathered rocks merge imperceptibly in color with those of the overlying and underlying zones. The fresh surface is pinkish gray, and in some places is streaked with light gray to white flattened pumice fragments. Generally the gray zone is the thickest zone of the sheet, locally reaching thicknesses of over

1,000 feet. A minimum thickness is difficult to specify because of the eroded upper surface. However, east of Globe the gray zone loses its distinct identity; a streaky brownish grayish zone just above the vitrophyre is only a few feet thick, and it quickly grades upward into the white zone. It appears that the brown and gray zones tend to merge and finally pinch out where the sheet is thin.

The gray zone consists of phenocrysts set in a pinkish gray, aphanitic matrix. The texture is commonly indistinctly layered or foliated, and megascopically it appears as a rather wavy, subparallel flow texture of brownish to pinkish flow layers in a gray matrix. In some specimens it strongly resembles true flow structure, but careful scrutiny generally reveals that the layers are discontinuous. Upward the brownish and pinkish layers assume a dusky gray color, but the indistinct flow textures remain perceptible. The rock is lithoidal in aspect, and the microscope shows that the groundmass is cryptocrystalline.

Flattened pumice fragments are common in the gray zone. At their leastmost appearance in the section they are extremely flattened white disks, several centimeters in diameter and less than a millimeter in thickness. Upward they become progressively less flattened, gradually changing to lenticular ellipsoids up to a few centimeters in diameter and 2 or 3 centimeters thick. Xenoliths are common but not abundant in the gray zone; they comprise perhaps 1 to 3 percent of the rock.

Most phenocrysts in the gray zone appear fresh, but the biotite shows signs of alteration. Progressing upward from the brown zone to the gray zone, biotite gradually loses its shining black or dark brown color and takes on a golden or light brown glint. Most of the biotite in the gray zone is slightly to moderately altered.

The gray zone grades upward into the white zone, and like its lower boundary, its upper boundary generally cannot be precisely located. The gradation consists of the appearance of very light gray material between the medium gray layers; these increase upward, and the proportion of medium gray material decreases. Farther upward the entire rock is very light gray, nearly white. In a few places a major change is rather abrupt, taking place across about ten feet, and although successive changes continue above and below this horizon, it is a convenient place to locate the boundary. At most places, however, the change is gradational over several hundred feet.

White zone

At the top of the ash flow sheet is the white zone. The fresh rock is soft and non-resistant, but when exposed to weathering a hard, protective layer coats the surface, with the result that most outcrops stand just as prominently as do those of the underlying, inherently harder rocks. The white zone is cut by the same system of vertical tectonic joints that cuts the gray zone, and these generally control the pattern of outcrop. The near-horizontal system is generally indistinct, probably because of the smaller amount of flattening of constituents. Weathered surfaces are brownish gray to pinkish gray, practically the same color as the weathered gray zone. Upward the weathered surface gradually becomes a lighter color, until near the top the color is a pale pinkish brown, distinctly lighter than the rocks lower in the section. The fresh surface is very light gray to white in color. The white zone has a maximum thickness of perhaps 500 feet, and averages 200 to 300 feet. Again, the thicknesses are uncertain because of the

gradational lower contact and the eroded upper surface.

The white phase consists of phenocrysts set in a very light gray to white, aphanitic matrix. In general no layered structure is perceptible, and the rock has a uniform, massive structure, but as the rock grades downward into the gray phase, a discontinuous irregular layered structure becomes distinct. The bulk of the white phase is firm and tough, yet its fresh surface is rather soft. Its induration is largely due to crystallization rather than welding. Spherulites and irregular shaped masses of fine microcrystals are abundant, and show that the groundmass is considerably crystallized.

Pumice fragments are abundant; they are only slightly flattened in contrast to the more thoroughly flattened fragments lower in the section. On the fresh surface the pumice fragments are nearly the same color as the enclosing rock, and in some places they are difficult to distinguish. However, the fragments weather to a lighter shade and generally stand out clearly in outcrop. Their susceptibility to weathering varies; in some places they weather away quickly and leave a surface pock-marked with cavities, and elsewhere they show about the same resistance as the rock that surrounds them. Xenoliths comprise about 1 to 3 percent of the rock. Ellipsoidal gas cavities are fairly common, some are lined or filled with small quartz crystals, and others are filled with light gray to brown powdery material.

Progressing upward from the gray to the white zone, biotite phenocrysts become more and more altered, gradually changing from a golden brown to dull dark brown, composed chiefly of iron oxide. The other phenocrysts remain fresh and unaffected by alteration.

In most places the white zone sheet has been deeply dissected or largely removed by erosion. However, a thick section of the white zone crops out east of Superior, and in the vicinity of Oak Flat it is likely that rocks representing the original top of the section are preserved. The uppermost part of the white zone is composed of white, punky tuff with low specific gravity, but it resembles the main part of the white phase in composition and texture. This is overlain by layers of ash with distinct bedding; a shaly contact marks the base of the ash, and it has been mapped as a separate unit.

Pumice fragments

Field occurrence and distribution

Light colored cognate inclusions are locally abundant in the lithic parts of the dacitic ash flow sheet. They were recognized and briefly described by N. P. Peterson and others (1951, p. 42) as follows: "In some very clean outcrops, what appear to be the shadowy outlines of dacite fragments are visible, suggesting that part of the rock is a firmly welded agglomerate." The fragments are lenticular and ovoidal in shape; toward the top they are nearly equidimensional and downward they are progressively flattened. Most of them range from one to four inches in their longest dimension, but both larger and smaller sizes are common. In general their light color contrasts with the slightly darker colored dacitic matrix. Most of them carry approximately the same assemblage of phenocrysts in about the same proportions as the matrix, and except for their lighter color appear to be practically the same rock.

Lenticular inclusions of this type are apparently very common in ash flow sheets. A few of the papers that mention and describe such lenticular fragments are Marshall, 1935, p. 332-335; Gilbert, 1938, p. 1835; Enlows, 1955, p. 1224-1231; Cook, 1957, p. 53-58, fig. 17; and Mackin, 1960, p. 89-95. Martin has suggested that most lentiles are of two principal types: "1) collapsed pumice lentiles, formed of flattened and welded glass and pumice lapilli; and 2) lithophysal lentiles, formed by crystallization in local pockets." (Martin, 1959, p. 403). Martin emphasizes that the two types are commonly similar in appearance and difficult to distinguish from each other, and he discusses

criteria for their recognition (p. 405-407). Although their original textures have been obliterated by crystallization, the great majority of the lenticles in the dacite of the Globe-Superior region are considered by the writer to be collapsed pumice lenticles. The principal evidence supporting this view is that most lenticles contain phenocrysts, and phenocrysts would have no chance to develop in lithophysal cavities. Although some lenticles do not contain phenocrysts and perhaps represent lithophysal crystallization, most of the lenticles are regarded as cognate pumiceous inclusions.

The lenticles are not uniformly distributed through the sheet. They are most common in the white and gray zones, rare in the brown zone, and absent in the vitrophyre and basal tuff. Moreover, their abundance varies within the white and gray zones; in some localities they comprise nearly one-fourth of the rock, and in other places they are scarce. In general the lenticles are especially abundant in the area of Superior and Devils Canyon, and in the areas of Pinto Creek, Webster Mountain, and vicinities. Eastward they become more scarce, and near Globe the lenticles are practically absent.

In cliff faces along Apache Leap, Queen Creek Canyon, and Devils Canyon, some successive layers of dacite may erroneously appear to contain widely different amounts of pumice fragments. When viewed from a distance, certain layers have highly pitted weathered surfaces, the pits representing weathered-out pumice lenticles. Adjacent layers above and below show few or no pits. At spots accessible for closer examination, however, it was found that the adjacent layers contain just as many lenticles as the pitted layers, and that the difference in appearance is caused by

the character of the weathering. The underlying cause of this weathering difference is not known. Sporadic attempts at mapping these layers to determine their distribution have not been successful; the locally distinctive layers commonly lose their identity when traced laterally, many are inaccessible, and they cannot be distinguished on subdued slopes.

Flattening of the pumice fragments

In the upper part of the white zone, pumice fragments tend to be nearly equidimensional in shape and show little preferred orientation. Lower in the white zone the fragments become slightly flattened, with ovoidal shapes, and are oriented with their longer dimension in the horizontal plane. Further downward the flattening increases, until well down in the gray zone the flattening has become extreme, and the fragments are streaks and stretched-out lenses. Lower still they may be represented by a mere coating on horizontal parting surfaces, and finally they completely disappear.

Cross sections of fragments exposed on surfaces parallel to the flattening are practically equidimensional, indicating that the flattening is a foliation, not a lineation. The lack of lineation suggests that while the fragments were being squeezed the deposit was not being laterally transported, and leads to the conclusion that the material was deformed only in response to the vertically superimposed load.

Although the downward trend seems to consist of a progressive increase in flattening, in any single outcrop individual fragments vary widely in the amount of flattening, and simple field observation is not sufficient to determine if the downward increase in flattening is systematic. Several localities where a considerable thickness of the

ash flow sheet is exposed were selected to test the apparent trend of flattening. Fragments were measured at successive horizons up through each section. A compilation and comparison of the measurements confirms that the flattening increases as the distance from the top of the sheet increases, and shows furthermore that the amount of flattening is an approximate guide to the distance below the top.

Method of making and interpreting the fragment measurements

The length of a fragment may be divided by its height to give a quotient, which in this paper is called the "flattening ratio". An undeformed equidimensional fragment would have a flattening ratio of one, and if slightly deformed its flattening ratio would be greater than one. As deformation of an originally equidimensional fragment increases, its flattening ratio correspondingly increases, and highly deformed fragments have flattening ratios up to 30 or more. Calling the quotient of length/height by the term "flattening ratio" implies an assumption that every fragment was originally equidimensional, and such an assumption is obviously not valid. Smith (1960, p. 807) suggested that most pumice fragments before welding are not longer than three times their smallest dimension. Observations near the top of the ash flow sheet in the Oak Flat area suggest, however, that many of the nearly undeformed fragments do indeed have a flattening ratio of close to one. It is concluded that the uncertainty of the original shape of the fragments introduces an unknown error into the measured flattening ratios, but that this possible error affects the principal conclusions only slightly.

At each spot selected for study, the height and length of 30 or 40 fragments as exposed in a vertical face of an outcrop is measured.

The flattening ratio of each fragment is calculated, and the average flattening ratio for each particular spot is determined from the sum of the individual flattening ratios. The relative stratigraphic position of each spot is determined from the maps and cross sections of figure M. Figure F shows the relation between the average flattening ratio and the stratigraphic level for six separate cross sections in various parts of the ash flow sheet. The vertical scale is the stratigraphic distance above the base, and the horizontal scale shows the flattening ratio plotted on a logarithmic base.

The curves show that the mean flattening ratio progressively increases downward in the section. Curves SH, BC, and JK form nearly straight lines, and curve BC deviates only slightly. Curves SH, BC, JK, DC, and SS all slope consistently in the same direction, and have approximately the same amount of slope. Curve HDa shows a reversal of slope adjacent to local steepening, but the upper and lower parts resemble the other curves.

The flattening ratio of each measured fragment is also shown on figure F to illustrate the distribution of values at each locality. The standard deviation has been calculated, and 95 percent confidence limits based on the distribution of each assemblage are indicated on the diagrams.

In selecting outcrops on which to measure fragments, care must be taken that the exposed surface is normal to the plane of the flattening; otherwise the apparent height of the fragments will be too large, and the calculated flattening ratio will be less than its true value. Outcrops suitable for study are not plentiful, for in addition to the required near-vertical surface, the fragments must show a clear contrast with the matrix.

Although most outcrops above the horizon of extreme flattening reveal pumice fragments, relatively few reveal them clearly enough for reasonably accurate measurements. An optimum degree of weathering on the surface is required; fragments may be completely obscured on some weathered surfaces, and on others they have been weathered away to leave small pits. In some places the pits are suitable for measurements, but in other places weathering has enlarged the pits beyond the original dimensions of the fragments. Another difficulty may be encountered in the white zone on little-weathered surfaces of fresh road cuts and excavations. Here the fragments may not contrast sufficiently with the matrix to allow them to be distinguished, and only after a moderate amount of weathering has darkened the matrix can they be seen clearly enough to measure.

Inferences derived from the character of the flattening curves

As the slope of most of the curves of figure F is nearly uniform, the downward increase of flattening must depend on the constantly increasing factor of the weight of the overlying material. The greater the amount of overlying material, the greater will be the flattening. The steady, uninterrupted increase in flattening on most of the curves suggests that the entire mass was deposited in a relatively short time, and comprises essentially a single cooling unit. If the underlying material had cooled to rigidity, it would have remained nearly undeformed by successive eruptions. If an earlier eruption had reached a condition sufficiently rigid to resist deformation, the flattening curve would show a reversal because the underlying fragments would be less deformed. Below the break, such a curve could be expected to resume its gradual downward slope. A partial example of this type is curve EDa. Apparently the fragments at EDa 3 had more resistance to deformation than those at EDa 4, probably because they were cooler. This suggests a time interval between successive eruptions long enough to allow some cooling. As the break in the curve is but small, it is likely that the time interval was not very long. Evidence from the field and from specific gravity data support the opinion that a slight break in deposition occurred in the vicinity of section EDa, but that it is not a major break nor is it laterally very extensive. In general then, the nature of the flattening curves of figure F provide convincing support for the opinion that the entire ash flow sheet was deposited in a relatively short time.

The curves of figure F are roughly parallel to one another. This shows that the flattening increases downward at about the same rate at different places, and implies similar physical conditions within the sheet over a wide area immediately after its eruption. That is, temperature, pressure, viscosity, porosity, and other physical factors affecting flattening were probably more or less uniform from one locality to another.

The amount of flattening of the pumice fragments is a particularly useful measure of the degree of welding of the tuff because so much of the original groundmass texture has been obscured by crystallization. We may assume that the more the pumice fragments are flattened, the more intense was the welding. If this is a valid assumption, the increase in welding intensity continues downward until the pumice fragments are completely flattened and are represented by either a thin film or are not detected at all. For example, this condition is represented just below point SHa7 on curve SH. The tuff lying below this point is "densely" welded--the original pore space was essentially eliminated by processes of compression and fusion. The tuff lying above this point shows varying degrees of partial welding. The curves of figure F show, for this deposit, that dense welding is not attained until covered by from 500 to over 1,000 feet of material. Many deposits are described in the literature, however, where dense welding is attained under much smaller thicknesses.

Smith (1960, p. 823-824) has presented a concise and informative discussion of welding in tuffs. Among the variables affecting the amount of welding, he regards the temperature of emplacement and the thickness as the most important. He would conclude that a thin, highly welded deposit must have been very hot, that a thick, nonwelded deposit would have been relatively cool, and so on. The curves of figure F show that the downward rate of increase of welding is relatively slow in the dacite of the Superior-Globe area. These curves therefore lead to the conclusion that the temperature of emplacement of the deposit was relatively low.

The consistency of the flattening curves has certain practical applications. For example, an abrupt change in the amount of flattening between adjacent outcrops suggests that a fault passes between the outcrops, and this has proved to be one of the few criteria by which faults can be identified within the ash flow sheet. Furthermore, from the average flattening ratios on opposite sides of a fault, an appropriate curve in figure F will show the approximate relative stratigraphic level of each of the points, and thereby it gives an estimate of the amount of throw on the fault. This method is not exact, but it does provide a means for estimating displacement where heretofore none has been available. The approximate displacements cited in the section on faulting were determined by this method.

Where the ash flow sheet has been deeply dissected by erosion and the top removed, the flattening ratio may permit an estimate of the former full thickness. From the flattening ratio the relative stratigraphic position can be determined on some curve in figure F. If a curve is projected upward to the left, it will ultimately reach some indeterminate

point that lies at the original top of the non-eroded sheet. It might be empirically assumed that a flattening ratio equal to one would represent this point. Such an assumption, however, can be made only with reservations because: 1) Many pumice fragments were not originally equidimensional, and these would have a tendency to land with their longer dimensions horizontal. Therefore, near the top of the deposit the dimensions of the fragments do not necessarily give a true representation of the amount of flattening. 2) Because the top is exposed to the atmosphere, the physical conditions affecting amount of flattening can be expected to be different from conditions lower down where the material is well insulated. At the top, the chilling effect of the atmosphere, smaller superimposed load, and other irregularities would introduce factors having various uncertain effects on the degree of flattening. The flattening curves would not necessarily remain linear near their tops, but would be likely to depart from the nearly consistent behavior they exhibit throughout the lower part of the unit.

Distinct irregularities are observed in the upper part of the single curve of figure F which approaches the true top of the deposit, curve SH. It is concluded that any upward projection of the flattening curves must be accompanied by considerable uncertainty, and that any estimate of thickness by this method could be subject to a considerable error. However, if the curves were projected arbitrarily in a straight line to the point where the flattening ratio is unity, the errors introduced would be similar at different localities, and any estimated total thicknesses would be approximately correct relative to one another. The flattening ratios, therefore, provide a tool by which future studies

may enable workers to approximately determine the original thickness of the dacitic ash flow sheet at certain appropriate points, and ultimately may permit construction of an isopach map of the dacite.

Specific gravity

Specific gravity studies of ash flow sheets

An important criterion in the recognition of welded tuff deposits is the characteristic variation of specific gravity and porosity according to distance above the base. In his study of the New Zealand ignimbrites, Marshall observed a progressive decrease in specific gravity from the base upwards and recognized that this decrease illustrated that the amounts of compaction and welding were at least in part a function of the amount of overlying material. He cites figures showing the relation between specific gravity and distance above the base (Marshall, 1935, p. 339, 350-351). Gilbert showed for the Bishop tuff that the bulk specific gravity of the tuff progressively decreased from the bottom upwards (Gilbert, 1938, p. 1843). Enlows (1955, p. 1220-1221) has showed similar variations for the welded tuff at Chiricahua National Monument. In each of these examples, the authors show that porosity increases as specific gravity decreases. Composite diagrams showing the relations of specific gravity and porosity to the distance above the base for each of these deposits has been presented by Smith (1960, p. 826-827).

In 1948(?) N. P. Peterson made some preliminary studies of specific gravity variations in the dacitic ash flow sheet near Miami, Arizona, on specimens from Webster Gulch (N. P. Peterson, in press). He found that upward from the base the specific gravity increases through the basal tuff to a maximum value, in the vitrophyre, and that further upward in the lithic dacite the specific gravity remains constant. He noted this as a departure from the normal characteristics of welded tuff bodies, and this helped support his conclusion that the body of dacite is of

a different type than welded tuff deposits described in previous literature.

Procedure used for studying specific gravity

The aim of the specific gravity study was to learn how it varies from top to bottom and from one place to another in the deposit. Any specific gravity variations should help in interpreting the character of the ash flow sheet and in understanding its method of emplacement. The specific gravities of specimens collected from various levels of the deposit were measured. Their locations are shown on the map of figure M. Figure SG shows the bulk specific gravity of each specimen and its stratigraphic distance from the base.

It was necessary to make a large number of specific gravity determinations, so a quick and simple procedure was essential, even though it might sacrifice some accuracy. The method selected was to measure the bulk specific gravity of the rock on a simple beam gravity balance. The rock was successively balanced in air and then in water, and the distance of the rock from the fulcrum at each balancing was used to calculate the specific gravity. These values of specific gravity are not necessarily highly accurate, but the accuracy is sufficient to show the general trend of specific gravity variations between rocks from the bottom to the top of the deposit. Repeated determinations on single specimens showed reproducability to about ± 0.02 units, and determinations on different specimens from the same locality were generally accurate to within ± 0.03 units. Determinations were less accurate on the porous rocks, because as soon as immersed the specimen begins to absorb water and the apparent weight continually increases. This error was partly

offset by loose surface material sloughing off during immersion. However, after some practice on the apparatus an approximate balance could be obtained almost immediately after immersion of the specimen, and the specific gravity values are thought to be reasonably accurate, at least relative to one another. Other possible sources of error would be from xenoliths of appreciably different specific gravity, and from possible vugs inside a specimen. More refined methods would undoubtedly yield more accurate results, but the additional expenditure of time would not be economical in attaining the desired results.

Porosity

Gilbert (1938, p. 1842-43), Emlows (1955, p. 1220-21), and N. P. Peterson (in press) determined the porosity as well as the specific gravity of their specimens. Since porosity determination is a time-consuming procedure, individual porosity determinations were not made in the present study. However, the powder densities of the rocks submitted for chemical analysis were determined by the Denver Rock Analysis Laboratory of the U.S. Geological Survey, and these are shown in table __ . If both powder density and bulk specific gravity of a rock is known, its porosity can be calculated, and the porosity bears a simple inverse relation to the bulk specific gravity. The three curves of figure SG2 show the relation of porosity to bulk specific gravity based on the maximum, minimum, and mean rock powder densities of table __ . If a proper value is selected for the powder density, the porosity of a specimen can be determined from figure SG2.

Variations of specific gravity

The curves of figure SG show how specific gravity varies according to the level of the specimen in the sheet. A separate curve is shown for each section, with specific gravity as the horizontal scale and distance from the base as the vertical scale. The location of each section is shown on figure M. Since different sections have different thicknesses of non-welded tuff at the base, the lowermost completely welded vitrophyre was arbitrarily selected as the origin for the vertical scale, and distances are shown both above and below the zero horizon.

In a typical section, with nonwelded tuff exposed at the base, the specific gravity increases upward to the vitrophyre; this agrees with N. P. Peterson's observations (p.). This upward increase in specific gravity appears at the base of sections QC, PCH, GG, NG, KC, and DC. A similar increase in specific gravity was also recorded by Marshall (1935, p. 339) in one of the New Zealand sections and by Enlows (1955, p. 1220) in one of the Chiricahua sections. Progressing upward, each of the specific gravity curves of figure SG has its own individual shape, but certain general characteristics in behavior are noted. In sections where the total thickness exceeds about 600 feet, the specific gravity remains nearly constant with only minor variations, until close to the top it begins a progressive decrease. In some of the thinner sections, such as JK and NG, the specific gravity begins to decrease right above the vitrophyre. In most of the curves, the decrease at the top is consistent, and though in some curves a slightly erratic pattern is noted, in all but KDa the decline is generally persistent.

At the base the lowest value of specific gravity recorded was 1.8, and the specific gravity increases upward to between 2.40 and 2.45 in the vitrophyre. In some sections the specific gravity continues to increase upward above the vitrophyre to reach values of 2.50 to 2.54 in the brown and gray zones. In sections ST and SH the specific gravity remains close to 2.5 for over 1,000 feet. In the other thick sections, such as QC, KC, DC, WM, and PCH the specific gravity persists above 2.4 to nearly the top of the section. The minor fluctuations of specific gravity on the vertical part of the curves are probably not significant, but instead reflect the inaccuracies of the procedure as discussed above. However, the possibility should be allowed that more rigorously selected samples spaced closer together in the sections might reveal minor variations with some significance.

The decline in specific gravity begins as much as 500 feet below the apparent top of the section, as in section SH. However the distance below the true top of the ash flow is either unknown or uncertain in most places because the original top has been mostly or entirely removed by erosion. The specific gravity declines from 2.4 or 2.5 to a minimum of about 2.1, but more commonly to about 2.2. These values are in marked contrast to the specific gravities at the tops of the ash flow sheets of New Zealand, Bishop, and Chiracahua, for which values of 1.5 to 1.8 are reported.

Some of the curves show a regular decline, whereas others are somewhat irregular. In view of the sources of error in determination of specific gravity, small variations are regarded as not sufficient to detect interruptions in deposition, but if accompanied by other evidence, specific

gravity, small variations are regarded as not sufficient to detect interruptions in deposition, but if accompanied by other evidence, specific gravity variations may provide support for such interruptions. Therefore the minor irregularities in the upper part of curves SH, WM, PCH, JK, and EC are probably not significant. However, the abrupt upward increase of specific gravity between specimens EBa4 and EBa5 is accompanied in the field by a local upward change from a white groundmass to a gray groundmass. Together these data suggest a local interruption in deposition.

Inferences derived from the study of specific gravity

The first and most important conclusion to be reached from the specific gravity study is that the nature of the variations of the specific gravity support the view that the major part of the ash flow sheet comprised a single cooling unit. If any part of the sheet had cooled appreciably before the following eruption was deposited, its upper part would show a decline in specific gravity, overlain by an abrupt increase. This is precisely what curve EBa shows. The lack of appreciable zig-zagging in most curves suggests that the ash flow sheet is essentially a single cooling unit. If successive eruptions had been separated by much time, sawtooth curves of the type shown for section EBa would be characteristic throughout the entire ash flow sheet. Curves of the type of QC, PCH, and EC would be obtained only if the ash flow sheet cooled as a single unit.

The increase of specific gravity downward from the top is obviously due to the long-recognized factor of the increasing weight causing increased compression in the rock. At the point where the specific gravity reaches

a constant value, close to its maximum, it might be supposed that the compaction was maximum, that the porosity was essentially nil, and that welding was complete. The complete welding would persist nearly all the way to the base. The more rapid chilling at the base caused a progressive downward increase in particle rigidity accompanied by a decrease in the amount of compaction and welding. This explains the progressive downward decrease in specific gravity at the base.

Increasing compression at depth with chilling at the base can explain the successive specific gravity decline at the top and the base of the deposit, but can they alone explain the thick zone of constant specific gravity? A comparison of the specific gravity curves with the flattening ratio curves suggests that the zone of maximum welding is much more restricted than is the zone of maximum specific gravity. Figure P shows that pumice fragments continue to be progressively flattened far lower in the sheet than the point where specific gravity reaches its maximum. What is the explanation to this apparent paradox?

It is likely that the degree of deformation of the pumice fragments represents at least in a general way the amount of deformation in the finer ash of the groundmass. Although there is probably a considerable differential in the absolute amount of deformation between fragments and particles of different sizes, the relative amounts of compression and welding are probably roughly equivalent. Therefore, where pumice fragments are but slightly flattened, it is likely that the finer particles comprising the groundmass are relatively less welded even though the bulk specific gravity is maximum. Let us visualize the

conditions in this zone right after eruption where the pumice fragments and groundmass ash are only partly welded but where specific gravity is now maximum. Immediately after emplacement, compression, and welding of the mass, the porosity was probably still relatively high in this zone, and the bulk specific gravity was correspondingly low. As cooling progressed, the glassy matrix crystallized, and furthermore crystals were deposited by vapors in the pore spaces. Because the deposit was thick, cooling was slow, and crystals continued to grow in the pore spaces until in this zone they were completely filled.

Maximum specific gravity represents essential elimination of pore space in the tuff. In many ash flow sheets the reduction of porosity is a direct function of the degree of welding, and maximum specific gravity indicates complete welding. In this deposit, however, maximum specific gravity is attained even in the zone of partial welding, and in this zone the porosity was eliminated by crystal growth during cooling instead of by complete welding. The degree of welding must here be determined from the shape of particles and fragments and from other textural evidence instead of from the specific gravity.

On page ___ it was noted that at the top of the sheet the minimum specific gravity is about 2.1, considerably more than that recorded for other ash flow sheets. Besides removal of the former top by erosion, crystal growth in pore spaces is very likely a major reason for this abnormally high minimum value.

Structure of the ash flow sheet

Faults

The dacite in the vicinity of Superior, Miami, and Globe Arizona is essentially a sheet-like deposit. The rock was laid down on a surface of considerable relief. The attitude of the layering varies from horizontal to dips up to about 30°; in a few places the dips are at greater angles. In several places throughout the area, early workers recognized post-dacite faults where they offset the edges of the dacite body. However, before the present study, faults were not followed away from the borders, because of the seemingly uniform lithology, and little of the published work shows faults within the ash flow sheet.

The zoning of the ash flow sheet and the systematic changes in flattening ratios are tools that have permitted faults to be recognized and mapped. Because weathered surfaces of different zones have nearly a uniform appearance, the mapping is difficult and slow, and only a sample area has been mapped in detail. This detailed area lies in the northeast and central parts of the Superior quadrangle and is shown on fig. __ . For this study the dacite was divided into 3 units. The lowermost unit includes the basal tuff, the vitrophyre, and the brown zone. The middle unit represents the gray zone, and the upper unit represents the white zone. As the brown, gray, and white zones are gradational into one another, the contacts between these map units can be only approximate. However, by tracing these approximate contacts on the ground, several faults with large displacement have been recognized. Figure __ shows that they are principally north-south faults with the west

side downdropped. The faults are recognized by abrupt lateral changes of groundmass lithology. That is, the groundmass color of freshly broken rock specimens is different on opposite sides of a fault. Weathered surfaces commonly appear the same on both sides; only in a few could a fault be recognized from changes visible on weathered outcrops. In scattered localities fault zones are marked by brecciation and slickensides, and in some places faults identified first from lithologic evidence could be confirmed by well exposed fault zones. Further support for these faults is provided by abrupt lateral changes in the flattening ratios of pumice fragments.

Many smaller faults transect the ash flow sheet, but it has not been possible to map them in the time available. Detailed work on these minor faults would be extremely tedious because with decreasing displacement the lithologic differences on opposite sides of the fault become less distinct. Other large faults cut the dacite in areas outside that mapped in detail, and a study of these structures would be an important contribution to understanding the tectonic history of the region.

Joints

Nearly everywhere the dacite is cut by a system of vertical or near vertical joints. They vary from clearly defined to indistinct, and from widely to closely-spaced. Generally the joints are from 5 to 15 feet apart, but they may range from a few inches to more than 40 feet apart. They commonly form distinct joint systems, in which parallel joints extend continuously for several hundred feet to over a mile. In many places two joint systems intersect each other at angles from 60 to 90 degrees. The continuity of the joints indicates that instead of being simple cooling cracks, they are of tectonic origin. The possibility should be allowed, however, that the joint systems developed during the cooling of the mass, and that their directions were controlled by stresses imposed by regional tectonic activity. Polygonal cooling joints are found in a few places, mainly in the vitrophyre zone. The present study has included but little work on the joints, and only in a few places are their attitudes and directions recorded. A detailed study of the joints would undoubtedly be helpful in reaching a better understanding of the structural history of the area.

Source of the dacite

Smith (1960, p. 817-820) has summarized the available information on source areas of ash flows. He lists the major types of source areas as domes, craters, fissures, calderas, and volcano-tectonic depressions. He has correlated the different types and sizes of ash flows with the information available on their source areas, and he concludes that the source areas of ash flows deposits with volumes of more than a few cubic miles almost invariably show subsidence structures. This implies that either calderas or volcano-tectonic depressions are the sources of most large ash flow deposts.

This ash flow deposit contains at least 40 cubic miles, or 115 cubic kilometers of material. On the volume scale of Smith (1960, p. 819) this deposit falls in the range of magnitude order 6, which suggests that it issued from a caldera or volcano-tectonic depression. The age of this deposit, probable mid-Tertiary, makes it unlikely that any subsidence at the time of eruption would still exist as a topographic depression. The mapped area has been examined for possible evidence indicating subsidence at the time of eruption. Strong, but not conclusive evidence indicating a caldera has been found in the southwest part of the Haunted Canyon quadrangle. The evidence includes: 1) complex and jumbled relations among different rock units around the edge of the proposed caldera. 2) dacite shows intrusive relations into older rocks within and along the edge of caldera in a few places. 3) older rocks are strongly brecciated adjacent to the caldera. 4) large broken blocks of older rocks lie in the volcanic rock close to the edge.

5) an unusually large number of inclusions are locally found in the dacite within the caldera. 6) dacite and earlier volcanics are locally permeated by alteration within the caldera. 7) relative proportions of phenocrysts of rocks within the caldera resemble the proportions found in the upper part of the outlying dacite, but differ from rocks lower in the sheet. The approximate boundary of the proposed caldera is outline on the map of fig. __ . Detailed geology is shown on fig. __ .

The border zone that contains most of the evidence forms a nearly circular ring 3 to 3½ miles in diameter. On Sawtooth ridge about 1 mile west of the Kennedy ranch, all the outcrops of the Paleozoic sedimentary rocks are highly brecciated. Many of the contacts between volcanic rock and the older rocks are shown on the map as faults because the mapping was done before the possibility of a caldera was considered. If this area actually represents a caldera, the older rocks would have been engulfed by the volcanic rocks, and the contacts would be intrusive instead of faults.

Proceeding southeastward clockwise around the Caldera border, across Rock Creek to a point due east of Bull Basin, Paleozoic sediments and diabase continue to be considerably brecciated, and the various rock formations bear complex and abnormal relations to each other. Irregular dike- and sill-like bodies of dacite transect the jumbled older rocks. Relations in much of this area are obscured by a heavy cover of brush, and unfortunately the contacts between dacite and older rock are not sufficient to clearly interpret the geology, but alternative explanations of the relations are possible. I originally thought the complexities were due to intricate faulting of tectonic origin. However, the complete

heterogeneity of bedding attitudes and fault patterns, and an interpretation of the abundant small dacite outcrops as intrusions extending into older rocks, agree with the view that these rocks were involved with the collapse of a caldera.

Dacite is the only rock that crops out from the area east of Bull basin to the southeast flank of Government Hill, at which point brecciated blocks of Escabrosa limestone and earlier volcanics are surrounded by dacite. The dacite above the blocks is firmly welded aphanitic tuff, rather than the ordinary basal zone of non-welded tuff grading to vitrophyre. The contacts at the sides and base of the blocks are covered by brush and talus, and these critical relations could not be observed, but the relations as far as they are exposed are consistent with engulfment during a caldera collapse.

From this point an apparent fault between dacite and the older rocks can be traced southward for about a mile. The adjacent diabase and Paleozoic sediments continue to show considerable brecciation. The actual contact between dacite and older rocks, though precisely located, is not exposed well enough to observe the detailed relations. However, interpretation as either an intrusive contact or as a fault with the west side downdropped, is consistent with the collapse of a caldera.

Southwest of Tony Ranch, the probable fault bends and continues in a west-southwesterly direction for about one-half mile before losing its identity in volcanic rocks. Continuing clock-wise around the caldera, the border zone between this point and the head of Haunted Canyon consists

of complex, apparently intrusive relations between altered dacite, altered rhyolite, and quartz monzonite intrusives, and a thoroughly shattered and brecciated block, about a mile in diameter, of diabase and Apache group rocks. This block is locally transected by dacite dikes, which in a few places are well exposed and exhibit distinctly intrusive relations. From the point north of the divide between Haunted Canyon and Wood Camp canyon, the border of the proposed caldera bends northwestward. The rocks along the border consists of brecciated and faulted Apache group rocks and diabase intruded by quartz monzonite porphyry. The rocks within the caldera are the earlier volcanic rocks and consist of considerably altered rhyolites and tuffs. A mile or so to the northwest, a series of nearly vertically dipping and overturned Apache group rocks are encountered. These rocks are relatively unfaulted and unbrecciated, they dip steeply toward the caldera. As this is the only place in the entire area that vertically dipping sediments were encountered, and since the beds strike parallel to the border of the caldera, it is possible that their attitude was determined by the collapse of the caldera. These beds strike northwestward and the outcrops continue for about a mile. Beyond this point the edge of the caldera is marked by sheared and brecciated diabase and early pre-Cambrian igneous rocks. The border of the caldera bends to extend nearly northward, and continues until it again crosses Sawtooth Ridge. The older rocks along the border are sheared and brecciated, and locally zones of alteration are found. The earlier volcanic rocks on Sawtooth ridge consist mainly of altered rhyolite, and in a few place viscous plugs have possibly intruded indistinctly

layered flows and tuffs. The border of the caldera bends to the northeast and extends parallel to Sawtooth Ridge, probably along its northern flank. The older rocks along this border consist of extremely faulted and brecciated Apache group and Paleozoic sediments, diabase, and Ruin granite. Some of the mapped units consist entirely of brecciated blocks and fragments of the particular formation. Other smaller totally brecciated units have been included with the earlier volcanic rocks on the map.

The deformation in this area is extraordinarily complex, possibly because the northeast-trending Kennedy fault intersects the border of the caldera in this area. It is not known whether or not the caldera collapse and the Kennedy fault are contemporaneous. However, it is likely that much or all of the movement on the Kennedy fault occured after the eruption of the dacite. This is because the dacite southeast of the fault is quite thick, whereas no dacite is found within several miles of the fault on the northwest side. Only in the extreme northwest corner of the Haunted Canyon quadrangle is dacite again encountered. It is reasonable to presume that dacite once covered the intervening area, but due to the uplift of the block northwest of the Kennedy fault the dacite has been stripped away.

Much of the dacite within the boundary of the proposed caldera has an appearance rather different from the dacite of other areas. It is a subtle difference and is not easy to specifically define. Megascopically the groundmass appears to be partly bleached. Under the microscope thin sections of these specimens show that considerable clay

and calcite have formed in the groundmass, and that feldspar, particularly plagioclase, has been partly altered to clay and calcite. This suggests that mild hydrothermal alteration is the cause of the distinctive appearance of the rock. Alteration effects would be expected in a source area, so their presence within the proposed caldera and their absence elsewhere provides support for the view that this site was an eruptive source of the ash flow sheet. Efforts to map alteration zones within this area were not successful, because transitions from altered to unaltered rocks are completely gradational, and even the most altered rocks do not present an appreciable contrast to unaltered rocks on weathered surfaces. The modal analyses of rocks within the proposed caldera are slightly but distinctly different from most of the dacite from other areas. These differences are discussed more fully in the section on petrography. Briefly, however, the modes from the dacite within the caldera correspond most closely with the modes from the upper dacite zones in outlying areas. This suggests that the rock within the proposed caldera is closer to the mineralogical composition of the rocks erupted last in the dacite series. This is compatible with the view that the caldera is a source area for the dacite.

A comparison of the volume of the ash flow sheet and the volume of the caldera suggests that a collapse of this caldera alone cannot account for more than a half or quarter of the material comprising the ash flow sheet. If we assume that the original area covered by the deposit was 400 square miles, and that the average thickness was slightly more than 300 feet, 40 cubic miles was the original volume of the deposit. The

maximum diameter of the caldera is about 3½ miles, and its area is roughly 10 square miles. If the volume of surface foundering must equal the volume of the deposit, 4 miles of vertical downward movement would be required. While no evidence is available on just how much the movement might have been, 4 miles is almost certainly excessive. We might assume, however, a subsidence of one to two miles. This would account for a volume of 10 to 20 cubic miles of rock, and leave some 20 to 30 cubic miles unaccounted for.

Any of several possibilities might account for the remaining rock:

1. Other source areas may lie in the vicinity that have not yet been recognized. They might be concealed under either dacite or Gila conglomerate, or they might lie outside the area that has been mapped.
2. Less intense subsidence may be distributed throughout the area around the caldera. For example, part of the subsidence of the graben between the Kennedy and Gold Gulch faults may be due to withdrawal of volcanic material. The entire 40 cubic miles could be attributed to an average subsidence of one-half a mile over some 50 square miles of this graben plus an additional 1½ miles of subsidence of the caldera.

In summary, geological evidence in the southwest part of the Haunted Canyon quadrangle suggests the presence of a caldera, which may have been a source for part of the ash flow sheet. Evidence pointing to a caldera is not conclusive, but the available facts seem at least to be compatible with the idea of a large scale collapse, and none of the facts seem contrary. If this feature is a caldera it is most likely one of the source areas that erupted the dacitic ash flow sheet of the Superior-Globe-Miami-area.

Petrography and mineralogy

Phenocrysts

The nature, distribution, and appearance of the phenocrysts throughout most of the ash flow sheet is remarkably constant. The phenocrysts are nearly uniformly distributed, and they comprise from 35 to 45 percent of the rock. Plagioclase is the most abundant phenocryst mineral, followed by lesser amounts of quartz, biotite, sanidine, and magnetite. Hornblende is present in some specimens and absent in others. Sphene, apatite, and zircon are common accessories, and a few specimens contain a little cordierite. The relative proportions of different kinds of phenocrysts vary only slightly from one zone to another and from place to place. The major phenocrysts generally average between one-half and 1 mm in diameter, and a few are as large as 3mm.

The phenocrysts of all zones of the sheet have a uniformly fragmental appearance that is particularly apparent when a large field is viewed under the low power of the microscope. It is due to broken faces on many of the phenocrysts and to abundant tiny angular pieces scattered through the matrix. The fragmental appearance is not so obvious under medium and high power, nor is it particularly noteworthy in most hand specimens, but it stands out strongly under the microscope when magnified about 25 diameters (fig's ___ ___ ___). This fragmental appearance is one of the criteria suggesting that the constituents of the rock underwent violent treatment during some stage of their development. This type of texture is common in pyroclastic rocks but rare in lava flows.

Basal tuff

The tuff at the base of the ash flow is typically a nonwelded vitric crystal tuff, with phenocrysts set in a vitroclastic matrix. The tecture of the basal tuff is unmistakably pyroclastic; thin sections show cuspate and lunate glass shards interspersed with fine dust. Figures _____ illustrate the texture of the basal tuff.

In the lower part of the tuff, shards are undeformed and randomly oriented, but upward they show a tendency to become squeezed and flattened. This tendency marks the transition between the basal tuff and the vitrophyre.

The shards and ash fragments that comprise the matrix of the tuff are mainly isotropic, so the material that comprises the matrix of the tuff is largely glass. The index of refraction of the glass ranges from 1.496 to 1.499. Some shards and fragments show dim birefringence, indicating slight devitrification. A preliminary X-ray study suggests that the matrix contains K-feldspar, cristobalite, and a zeolite mineral, probably clinoptilolite. All the phenocrysts in the tuff are fresh.

Vitrophyre

The vitrophyre zone consists of highly welded vitric crystal tuff, with phenocrysts set in a completely glassy groundmass. Although megascopically much of the glass appears massive and uniform, under the microscope the glass is typically seen to consist of individual shards and fragments that have been flattened, distorted, and tightly welded together. Under medium and high power, the vitrophyre commonly exhibits textures that are characteristic of the welded tuffs described in the early, widely known papers of Marshall (1935), Smith and Ross (1935),

and Gilbert (1938). In the vitrophyre these typical textures are readily identified, but in parts of the overlying zones they have been partly to completely obscured by devitrification and crystallization.

In most of the vitrophyre the groundmass consists of two separate types of glass that show varying amounts of contrast with each other. One type comprises the shards and lapilli, and the other comprises the intervening matrix. The glass of the shards and lapilli is typically clear, and contains little or no occluded dust or crystalline fragments. Its color in plane light ranges from colorless to light and medium brown. Color of this glass within a single specimen is generally uniform, but the color varies widely from one field location to another. The glass of the matrix is generally cloudy in appearance, contains moderate to large amounts of dusty material, and is highly charged with small, broken crystalline fragments. Under medium and high power it can be seen that the glass itself is colorless, but occluded dust commonly imparts an apparent brown or gray color. In some specimens the borders of the shards and lapilli are sharp and distinct and form a clear contrast with the matrix, but in others the borders are vague and the shards and lapilli tend to merge into the matrix.

Many textural details vary among vitrophyre specimens from different localities, but certain general patterns appear in most of the specimens (fig.). Distorted shards and lapilli of clear glass, from .5 to 20 mm long, are roughly to well aligned in the matrix of cloudy glass. Many shards show remnants of lunate and cuspate outlines that have been bent and distorted, but the present form of shards is typically lenticular (fig's ___, ___, ___). Shards longer than 0.5 mm are readily distinguishable in most vitrophyre thin sections. However,

in some sections, shards of a much smaller size, down to about 0.03 mm long, lie closely packed and aligned along subparallel structures in the cloudy glass of the matrix. Under higher powers of the microscope they show up as tiny, clear lenticles surrounded by dust-charged, cloudy glass (fig. ___). In the other direction of the size range, flattened lapilli grade upward in length to several centimeters, but most are less than about 20 mm. The lapilli commonly contains small amounts of dust, generally as discrete opaque grains. The dust grains generally are aligned in subparallel trains that define flow texture within the lapilli. Slight changes in color intensity in alternating bands of clear glass accentuate the flow texture. Lapilli in some specimens contain streaks of cloudy glass that follow the flow textures. In some lapilli the flow textures are smoothly and gently undulating; in others they vary through moderately distorted to highly contorted structures (fig's ____).

The cloudy glass of the matrix everywhere contains abundant tiny pieces of broken crystals. These tiny crystals fragments impart an apparent low birefringence to the matrix, whereas the shards and lapilli remain completely isotropic. This difference helps to distinguish the shards and lapilli from the matrix, especially in specimens in which borders are vague.

Textural details within each of the glass phases vary widely among different specimens; figure ___ illustrates a few of the differences. In figure (QCb5) the shards and lapilli are of medium brown, clear glass, and they stand out sharply from the matrix. The lapilli contain intricately contorted, colorless, dusty streaks. Cuspate and lunate forms that have been flattened and distorted can be noted on the smaller shards. The

cloudy, colorless glass of the matrix contains only a moderate amount of dust, and the thin section has a "clean" appearance. The deformed shards in figure (KC3) are clearly defined, and are quite uniformly dispersed through the matrix. Both the shards and the matrix are colorless, but the shards are clear while the matrix is highly charged with dust and broken crystal fragments, and the thin section appears to be "dirty".

In figure (PCd1) the shards and lapilli again form a distinct contrast with the matrix. The shards and lapilli are of clear brown glass, whereas the matrix is colorless, but is "dirty" from its high content of dust and fragments. Dust in the matrix is commonly aligned parallel to the long dimension of the shards. In figure Dld) the individual shards are distinguished chiefly by trains of dust aligned parallel to their borders in the adjacent matrix. Some shards clearly show distorted cuspate outlines. The greatly elongated lapilli vary from pale brown to colorless and show smoothly billowing, continuous flow textures, defined by colorless streaks and partly outlined by aligned dust trains. The glass of the matrix carries comparatively little dust, and the rock appears "clean". The shards and lapilli in most places stand out clearly from the matrix, but locally the borders are vague and gradational.

The entire groundmass of figure (BCb4) appears to be composed of colorless, deformed glass shards, tightly welded, with dusty borders defining their outlines. The matrix phase is relatively much less abundant than in most of the other specimens, and the closely packed shards comprise most of the glass. The lenticular shards are aligned nearly parallel to one another, and the structures are only gently

undulatory instead of highly contorted. In figure STb10) the clear colorless glass of the shards and lapilli contrast strongly with the cloudy matrix that is highly charged with dust and broken crystal fragments. Structures formed by the dust in this matrix are discontinuous and very irregular, and the rock is "dirty" in appearance.

Brown zone

The brown zone, like the vitrophyre, is composed of highly welded tuff, but instead of a glassy groundmass its phenocrysts lie in a cryptocrystalline groundmass. Original textures are generally preserved, and in the microscope the highly flattened and deformed shards and lapilli are readily seen to be tightly welded together. Crystallization, has been superimposed on the primary welded textures, and the brown zone is part of Smith's zone of devitrification (Smith, 1960, p. 831).

Under the microscope the minerals comprising the crystallized groundmass could be only tentatively identified as silica minerals and feldspar. On the X-ray spectrometer, however, the groundmass was determined to contain mainly crostobalite and K-feldspar, and subordinate amounts of quartz and plagioclase.

The primary textures of most individual specimens closely resemble those described for vitrophyre, and therefore, need not be repeated in detail. The principal difference is that the vitrophyre groundmass is glass, whereas the groundmass of the brown zone is generally cryptocrystalline. In the vitrophyre, distinct glass phases distinguish shards and lapilli from the matrix, and in the brown zone each of the two phases may show an individual character of crystallization, by which the two phases may be distinguished. In the shards and lapilli, the crystallization is

more prominent, as the crystals are generally larger than those in the intervening matrix. In some specimens an abrupt change in crystal size distinctly marks the borders of shards and lapilli (fig. ____). Forming the borders of most shards and lapilli are slender needles, probably of cristobalite and K-feldspar, arranged in radiating patterns to form spherulites, or in parallel comb-like structures to form axiolites (fig. ___). The individual needles range from 0.005 to about 0.05 mm in length. The interior parts of shards and lapilli are commonly intergrowths of tiny anhedral crystals, approximately equidimensional, which form random patterns. Individual crystals commonly range from barely dissernable to 0.01 mm in diameter.

Crystallization in the matrix is generally less well developed than in the shards and lapilli; in part of the matrix crystallization can be detected only as a faint birefringence, and individual crystals cannot be distinguished. In most areas, however, crystallization is distinctly visible as low birefringent aggregates and scattered spherulitic growths, probably mainly of cristobalite and K-feldspar. A fine brown dusty pervades most of the matrix. The dust is locally concentrated in lenticular, sinuous, and irregular bands, layers, and masses, and these concentrations reflect and sometimes emphasize the textural relations between shards and lapilli and the matrix. The dust is probably hematite, but it could not be positively identified as no X-ray patterns of the groundmass showed recognizable peaks corresponding to hematite.

In some specimens the anhedral crystals of the groundmass reach about 0.2 to 0.3 mm in diameter, and the intergrowths have granophyric texture. Quartz is the dominant mineral in the coarser grained intergrowths, accompanied by K-feldspar and a little plagioclase. It is not known whether this coarser crystallization was primary or secondary, that is, whether it developed during the original cooling of the rock or during subsequent diagenetic changes. If primary, the appearance of this texture is probably the beginning of a gradation to Smith's granophyric zone of crystallization (Smith, 1960, p. 831), and presumably indicates an unusually long period of cooling after eruptive emplacement

Individual variations among specimens from the brown zone is considerable. In some areas high concentrations of yellowish brown dust nearly obscure the primary eutaxitic texture (fig. 104). In some areas, even though the groundmass is lithoidal due to devitrification, the crystals are so small that the groundmass is nearly isotropic. In contrast, in many specimens the crystallization of matrix and shards has progressed far enough so that their boundaries have been obscured, and a clear distinction between the two phases is not possible. Dust and broken phenocryst fragments are generally more abundant in the matrix than in the shards. However, in some specimens dust and fragments have been mixed into the shards and lapilli, so the criterion of differential concentration of dust and fragments cannot be universally used to distinguish the phases.

In most specimens of the brown zone all the phenocrysts are entirely fresh. However, in the upper part of the zone, where the gradation between the brown and gray zone begins, biotite shows slight bleaching and development of opaque grains at its borders.

Gray zone

Rocks of the gray zone are welded crystal tuff, with phenocrysts set in a cryptocrystalline groundmass. Because the primary textures of the groundmass are partly to considerably obscured by crystallization, the degree of welding is not distinct. Interpretation of relict textures indicate, however, that the lower part of the zone is probably densely welded, and that within the zone the degree of welding decreases upward. The crystallization of the groundmass indicates that the gray zone is part of Smith's zone of devitrification, and it is likely that the upper part of the gray zone is grading into his zone of vapor phase crystallization.

In most specimens, identification of groundmass minerals under the microscope is only tentatively possible, and like in the brown zone, indicates silica minerals and feldspar. X-ray spectrometer patterns again show that cristobalite and K-feldspar are the principal groundmass minerals, and that quartz and plagioclase are subordinate. In some thin sections, groundmass crystals have grown large enough to permit visual confirmation of the X-ray data.

In at least some specimens in the gray zone, the two distinct phases of the primary texture can be distinguished by differential amounts of crystallization. Crystals in lapilli and shards are larger and more distinct; individulal fibrous crystals of the spherulites and axiolites along the lapilli borders reach 0.1 mm in length, and the anhedral crystals of their interiors are generally 0.001 to 0.02 mm in diameter. In general, the shards and lapilli are relatively free of dust and broken phenocryst fragments, though some mixing has occurred. In contrast, the crystals comprising the matrix are much smaller, generally

up to 0.05 mm, and in some places the matrix is nearly isotropic.

The size of the groundmass crystals tends to increase upward in the gray zone, and in some specimens no difference in crystal size is apparent between lapilli and matrix. As the degree of crystallization increases, considerable interpenetration occurs between shards and lapilli and the matrix, and the boundaries of the lapilli and shards become more and more diffuse. In many specimens, particularly in the upper part of the gray zone, the outlines of the original shard-size fragments have been completely obliterated by crystallization, and the borders of the lapilli are so vague that they can be recognized only with difficulty. The matrix generally contains considerable amounts of broken phenocryst fragments, and this differential concentration of crystal fragments and dust may aid in distinguishing primary textures where they have been obscured by crystallization.

The matrix is generally cloudy from a high content of dust, probably hematite, which is differentially concentrated into billowing and waving bands and lenticles that flow and swirl around phenocrysts and closely resemble true flow structure. Careful scrutiny shows, however, that the flow lines are discontinuous and lenticular, and that many of them are concentrations along borders of flattened lapilli. Lapilli range from a few mm to several cm in length, and if a thin section is cut through a large lapilli, apparent flow lines defined by dust concentrations may extend across the entire thin section. Unless microscopic observations are carefully correlated with close megascopic examination, it would be easy to erroneously conclude that this texture was developed in a lava flow. The obscuring of original pyroclastic texture by crystallization and the apparent flow structure imparted by

dust concentrations are probably the principal reasons that the dacite sheet was not earlier identified as being of ash flow origin.

Quartz, plagioclase, and sanidine phenocrysts remain fresh and unaltered through the entire gray zone. Biotite tends to be fresh in the lower part, but upward it shows progressively greater amounts of alteration. Alteration begins by bleaching at the borders and the development of small clots of opaque oxides in the bleached areas. Bleaching progresses inward, particularly along cleavage planes, and the opaque grains increase in size and concentration. Some of the biotite becomes partly altered to chlorite, whereas much of it remains as a lighter colored variety of biotite. Further alteration effects are noted in the overlying white zone.

Microscopic examination has not revealed any simple and straightforward reason for the difference in megascopic appearance between the rocks of the brown and the gray zone. No consistent color difference in the groundmass dust was noted under the microscope, but it is possible that changes of environment at different levels in the cooling unit could cause actual differences in the composition of the dust that would show up as a bulk color change. Whether or not such a change occurs in the dust is not known, but it does seem likely that the combination of several textural features may effect gradual upward changes which produce the zonal distinction. Those factors having most effect are probably the upward increase in groundmass crystal size, the more diffuse borders of shards and lapilli, the upward decrease in intensity of welding, and the introduction of vapor phase crystallization.

White zone

The white zone is composed of partly welded to perhaps nonwelded crystal tuff, with phenocrysts lying in a cryptocrystalline groundmass. The degree of welding must be mainly inferred, because the original groundmass textures are nearly all obliterated by crystallisation. Both devitrification and vapor phase crystallization have acted on the rocks of the white zone.

Groundmass minerals are identified under the microscope as silica minerals and feldspar. Some groundmass cristobalite and quartz can be optically discerned, and accasional tridymite crystals are noted. However, the great bulk of the material in the groundmass can bear only generalized optical identification. Preliminary X-ray work revealed K-feldspar and cristobalite as dominant, quartz subordinate, and just a little plagioclase.

The groundmass of typical specimens from the white zone is entirely cryptocrystalline, and consists of scattered spherulites and masses of randomly crystallized material. Locally the spherulites are closely crowded together and have mutually interferred with one another's growth, but in most places the groundmass is monomorphic with a light sprinkling of spherulites. In some places relict original textures can be distinguished; these are generally vaguely defined outlines of lapilli up to several millimeters in diameter. In a few places relict outlines of small lapilli and shards down to 0.1 mm in length can be identified.

The spherulites are probably composed of K-feldspar and cristobalite, and they generally range from 0.05 to 1 mm in diameter; they rarely reach 2 mm. They generally consist simply of radiating fibrous crystals, and their borders may be either sharply or vaguely defined. A few show concentric structures superimposed on the radial pattern. An appreciable number form complete spheres, but many consist of only partial sectors of spheres.

The bulk of the groundmass is mesomorphic, consisting of tiny intergrown crystals of silica minerals and feldspar. In some places they are fibrous or rod-like, but generally the crystals are anhedral and more or less equidimensional. Relict lapilli and shards may have a type of crystallization different from that of the matrix, that is, they may be coarser or finer than the matrix, have axiolitic borders, be crowded with tiny spherulites, or have some other distinctive crystallization pattern. Contrast between the crystallization textures show a great variety of possibilities, and no consistent interrelations between the lapilli and matrix could be detected. Grayish brown dust is abundant in both the spherulites and the mesomorphic part of the groundmass; generally only in the relict lapilli is the rock relatively free of dust. The dust is generally randomly scattered; only rarely does it become concentrated into flow-like bands as is in the brown and gray zones.

Quartz, plagioclase, and sanidine phenocrysts remain essentially fresh in the white zone, though quartz tends to be more deeply embayed. Biotite, however, is moderately to nearly completely altered. In some specimens the biotite is partly bleached with scattered clots of oxide, in other specimens it is considerably bleached and nearly opaque from

the crowded clots of oxide, in some it is partly to largely altered to chlorite, and in a few specimens only a shell of opaque oxide grains indicates the former presence of biotite. Surprisingly, even in rocks with extremely altered biotite, the scattered hornblende phenocrysts remain fairly fresh. An appreciable number of phenocrysts of graphically intergrown quartz and sanidine have been noted in the white zone. At the present time only their presence is recorded, and no explanation for them is offered.

Proportions of phenocrysts and their variations

Modal analyses of some sixty thin sections of dacite have been made. Most of the analyses were made using the Chayes point counting method, but a few were run on an integrating stage. Results of the analyses are shown in table G, and are graphically illustrated in figure G. These results show that most of the dacite mass has a nearly uniform distribution of phenocrysts, and that relative proportions of the phenocryst minerals to one another are fairly constant. The proportions of phenocrysts from dacite in the southwest part of the Haunted Canyon quadrangle, however, show a distinct and consistent difference from the phenocryst proportions in other areas. Also certain minor variations between zones are noted at some localities. To determine which of these differences are real and which are only apparent, statistical methods have been applied to the modes, and a summary is presented in table H. The confidence limits of some of the figures of table H are broad because the means are taken from only a few samples. More modal analyses are planned so that figures will be based on more samples, and perhaps the confidence limits can be improved. At any rate, some of

the present results should be regarded as only preliminary.

The statistical study reveals that:

1. No significant difference has been revealed in the total percentage of phenocrysts in the rocks from different zones or from different localities. Statistically the phenocrysts are uniformly distributed through the entire sheet.

2. The relative proportions of plagioclase, sanidine, quartz, and hornblende are significantly different between dacite from the southwestern part of the Haunted Canyon quadrangle and the dacite from other areas. These differences are generalized as follows:

	plagioclase	sanidine	quartz	hornblende
Southwest Haunted Canyon quadrangle	59½	16	19	nil
Other areas (omitting white zone)	71-74	2-3½	9-12	1-3

No significant differences are noted in the proportions of biotite, magnetite, or minor accessories.

3. The differences in proportions of plagioclase, sanidine, and quartz among the basal tuff, vitrophyre, brown, and gray zones are probably not significant.

4. The proportions of plagioclase, sanidine, and quartz of the white zone may be significantly different from the other zones, but more analyses are needed to narrow the confidence limits. It appears from present data that these proportions in the white zone are transitional between the rocks of the underlying zones and the rocks of the southwestern Haunted Canyon quadrangle.

These observations lead to the following conclusions:

1) the rock in the southwestern part of the Haunted Canyon has a significant difference in mineralogical composition from that in neighboring areas;

2) the rocks of the southwestern part of Haunted Canyon are closer in mineralogical composition to the rocks of the White zone than they are to the rocks of the lower zones.

These conclusions are compatible with the field and structural evidence for a source or vent area for the ash flow sheet in the southwestern part of the Haunted Canyon quadrangle. If the composition of the magma being erupted from a vent were to change in a particular direction, we should expect:

1) the rock occupying the vent at the close of activity to be different from the earliest rock erupted from the vent;

2) the rocks in the vent would be closer in composition to the rocks that lie at the top of the volcanic series, than they would be to the earlier rocks that are lower in the volcanic series.

These obvious conditions correspond precisely to the above conclusions. The changing phenocryst proportions, therefore, support the view that a source area for the dacitic ash flow sheet occupies the southwestern part of the Haunted Canyon quadrangle.

Plagioclase.--Through the entire ash flow sheet plagioclase is the major phenocryst. Crystals are generally subhedral and rarely euhedral. Twinning in the plagioclase is universal, and most grains are twinned after two or three twin laws. Albite, Carlsbad, and pericline are the most common, and Manebach, acline, and ala twins have also been recognized. Most plagioclase phenocrysts are distinctly zoned, and may show either normal or oscillatory patterns; a few phenocrysts are not zoned.

Efforts during the present study to determine the position of the plagioclase in the albite-anorthite series have not led to a unique answer. Determination of plagioclase composition, particularly in volcanic rocks, is no longer a simple matter of determination of extinction angles. Recent studies of the plagioclase series have shown that the optical properties depend not only on the position in the albite-anorthite series, but also on the structural state of the crystal lattice, which in turn depends on the rate of cooling during and after crystallization, certain particular events in the thermal history of the rock, and possible ionic substitutions in the plagioclase lattice (Tuttle and Bowen, 1950; Goodyear and Duffin, 1954; J. V. Smith, 1956; J. R. Smith and Yoder, 1956; MacKenzie, 1957; J. V. Smith and Gay, 1958). The ordered state of the crystal lattice is the low-temperature form of the mineral; it is found in plagioclase of plutonic bodies and the large gabbro complexes and represents long, slow cooling. The disordered state of the crystal lattice is the high-temperature form; it is found in synthetic plagioclase and a few volcanic rocks and represents rapid cooling. The plagioclase of most volcanic and hypabyssal rocks has a structural state intermediate between complete order and disorder. The widely-used extinction angle

curves were derived for low-temperature plagioclase; they furthermore were drawn by averaging points that may show considerable spread. As the plagioclase of this study is from a volcanic rock, it doubtlessly represents an intermediate- or high-temperature form. Therefore the An-content as given from extinction angle curves is likely to be in error.

Despite the uncertain results, extinction angles of plagioclase in thin section have been measured both on the ordinary microscope stage and the universal stage. Quick, routine determinations were made on most slides, and more detailed studies of about six slides have been made on the universal stage. No appreciable variations have been noted from one rock sample to another. Reasonably consistent values of An content were generally obtained, though a few determinations on complex twins deviated considerably from the bulk of the results. According to extinction angle curves, most plagioclase grains, including zoned crystals, fall in the composition range An 35-40. A few grains have centers as calcic as An 55, and some of their borders may reach An_{25}. Such wide variations are rare, however, and very few crystals show a range of more than about 10 percent An, centered about the interval An_{35-40}.

Perhaps one of the more reliable methods of plagioclase determination is from the index of refraction but even this is subject to some doubt. J. V. Smith and Gay (1958, p. 759) indicate that the An-content is but an estimate, as the standard curves have been obtained by averaging refractive indices of analyzed plagioclases. They point out that the variations of refractive index with the structural state have not been

systematically studied, but cite work by others that show appreciable variation in the refractive index from the ordered to disordered state for sodic plagioclase. They think that the refractive index is not much affected by the structural state in calcic plagioclase.

In this study the high and low refractive indices of cleavage fragments of plagioclase have been determined in immersion oils, and the plagioclase composition has been estimated from Tsuboi's curves (Winchell, 1951, p. 280). The determinations have been made on specimens KC1, 3, 9, 11, 12, and 13. Because of zoning, the refractive indices have a considerable range. However, for most grains lying on 001, the fast ray has a refractive index of 1.539-1.540, and the slow ray 1.547-1.548. Tsuboi's curves indicate a plagioclase composition of about An_{22-25} for these values. The minimum fast ray index observed was 1.534, equivalent to An_{14}, and the maximum slow ray index seen was 1.551, which for a grain lying on 010 would be An_{38}. No variation in average refractive index was noted from one rock specimen to another. It is likely that zoning extended over a wider range than was observed in this refractive index study. We may conclude that the average composition and the extreme ranges of plagioclase indicated by refractive index are considerably more sodic than those indicated by extinction angles. This plagioclase is probably sodic enough for the refractive index to be affected by the change in the structural state, so the indicated An-content must be regarded as uncertain. However, even if the maximum error of 5 percent is allowed (Smith and Gay, 1958, p. 759), the An-content determined from refractive index is considerably more sodic than that determined from the extinction angles.

This deviation shows that these data are not sufficient to yield a unique position or range of position of the plagioclase on the albite-anorthite scale.

Supplemental information can be provided from X-ray diffraction studies, but still a unique solution cannot be obtained. J. V. Smith and Gay (1959, p. 749, 754) have derived curves from which either An-content or structural state can be determined if the other is known. Although neither is known precisely, the optical studies have roughly indicated the composition, so the approximate structural state of the plagioclase can be deduced.

Figure X shows X-ray diffraction records of plagioclase phenocrysts from specimens KCl, 3, 9, 11, 12, and 13. Table X gives the recorded values of 2θ for the crystal faces $(\bar{2}01)$, $(1\bar{1}1)$, (220), $(1\bar{3}1)$, and (131), and the values of B (capital beta) and Γ (capital gamma) as defined by J. V. Smith and Gay (1958, p. 748, 749, 754). Figure X reproduces the curves of Smith and Gay showing the relation of B and Γ to An-content. Each value of B and Γ is plotted on figure X' against two assumed values of An-content; An_{22} yielded by refractive index, and An_{38} yielded by extinction angles from low-temperature curves. Although both points are probably in error, the true An-content probably lies somewhere nearby. For B the range of uncertainty is too wide to permit any useful conclusions, as it extends all the way from the low to the high temperature curve. The range is narrower for Γ, however, as the points fall midway between the low and high temperature curves. This confirms the suggestion that this plagioclase, from a volcanic rock, has partly ordered and partly disordered lattice structure.

Table __. Chemical analyses and norms of dacite

Chemical analyses	QCb5	SHa10	PCd1	CGe3	STb10	STd2
SiO_2	68.20	68.63	67.12	69.45	68.67	70.38
Al_2O_3	14.84	15.21	15.82	15.00	14.13	14.51
Fe_2O_3	1.95	2.80	2.39	2.67	1.34	2.22
FeO	.73	.14	.34	.09	.94	.35
MgO	.92	.80	1.15	.63	.83	.65
CaO	2.20	2.43	2.58	2.12	2.23	1.81
Na_2O	3.71	3.89	3.70	3.93	3.71	3.78
K_2O	3.88	3.83	3.87	3.84	3.76	4.08
H_2O-	.46	.79	1.15	.72	.79	.58
H_2O+	2.06	.40	2.22	.57	2.73	.70
TiO_2	.46	.50	.51	.47	.41	.44
CO_2	.00	.08	.08	.01	.00	.01
P_2O_5	.12	.13	.13	.12	.10	.11
MnO	.08	.09	.07	.07	.08	.06
Total	99.61	99.72	99.65	99.69	99.72	99.68
Norms						
Q	26.16	25.38	26.76	27.12	27.00	28.50
or	22.80	22.80	18.85	22.80	22.24	23.91
ab	31.44	33.01	31.44	33.01	31.44	31.96
an	10.01	10.29	11.95	8.62	10.29	8.06
C	.92	.82	1.12	1.22	.10	.92
en	2.30	2.00	2.90	1.60	2.10	1.60
hm	1.12	2.88	1.92	2.72	1.86	2.24
mt	1.16		.70			
il	.91	.46	.91	.30	.76	.91
ap	.34	.34	.34	.34	.34	.34
sp		.59		.78		

Rapid rock analyses

	KC-1	KC-3	KC-9	KC-11	Kc-12	KC-13
SiO_2	66.4	67.8	67.7	68.0	68.7	69.8
Al_2O_3	14.4	15.3	16.3	16.5	16.7	16.0
Fe_2O_3	2.1	2.1	2.5	2.6	2.7	2.2
FeO	.34	.77	.13	.12	< .1	< .1
MgO	.80	.72	.76	.52	38	.34
CaO	2.3	2.3	2.5	2.4	2.2	1.9
Na_2O	1.8	4.0	4.1	4.2	4.2	4.0
K_2O	4.3	3.6	3.6	3.5	3.6	4.0
H_2O	7.1	2.3	1.8	1.8	1.4	1.3
TiO_2	.41	.46	.43	.40	.40	.36
CO_2	< .05	< .05	< .05	< .05	< .05	< .05
P_2O_5	.10	.14	.16	.14	.15	.12
MnO	.09	.09	.08	.08	.08	.06
Sum	100	100	100	100	100	100
Sp. G. (Powder)	2.38	2.49	2.56	2.52	2.54	2.53
Norms						
Q	33.6	25.1	24.3	24.8	26.0	27.0
or	25.6	21.1	21.1	20.6	21.1	23.9
ab	15.2	34.1	34.6	35.6	35.6	34.1
an	10.6	10.6	11.1	10.6	8.3	7.8
C	2.9	1.2	1.6	1.9	2.5	2.1
en	2.0	1.8	1.9	1.3	1.0	.9
hm	1.9	1.1	2.6	2.6	2.7	2.2
mt	.2	1.4				
il	.8	.9	.5	.5	.3	.3
ap	.34	.34	.3	.3	.3	.3
sp			.4	.4	.6	.6

W	
QCb5	Vitrophyre, 1 mile northeast of Superior, Ariz.
SHa10	Dacite, gray zone, 1½ miles northeast of Superior
PCd1	Vitrophyre, 1 mile north of junction of Haunted Canyon with Pinto Creek, Haunted Canyon quadrangle.
GGc3	Dacite, gray zone, 1½ miles west-northwest of Porphyry Mountain, Inspiration quadrangle.
STb10	Vitrophyre, north side of Sawtooth Ridge, 0.7 miles southwest of BM 3677, Haunted Canyon quadrangle
STd2	Dacite, brown zone, Sawtooth Ridge, 1.3 miles southwest of BM 3677, Haunted Canyon quadrangle.
	Analyst for GCb5, SHa10, PCd1, GGc3, STb10, STd2: Dorothy F. Powers, Denver Rock Analysis Laboratory, U. S. Geological Survey.
KC1	Basal tuff, northeast of Kings Crown Peak, Superior quadrangle
KC3	Vitrophyre, " " " "
KC9	Dacite, brown zone, " " "
KC11	Dacite, gray zone, " " "
KC12	Dacite, white zone, " " "
KC13	Pumice fragments in white zone, " "
	Analysists for KC series, F. L. D. Elmore, S. D. Botts, I. H. Barlow, G. Chloe, (Rapid rock analyses). U. S. Geological Survey.

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LIST OF REPORTS, ATTACHMENTS, APPENDICES ETC.
FOR THE SUPERIOR EAST PROJECT

	Title	Subject	Where Found
Reports:	Summary of Superior East Project, Dacite Studies	Summary of Studies	Report to W.E.S. 4-14-71
	Addenda A	Superior dacite, pumice flattening ratios, thickness estimates and zones	Report to J.D.S. 4-20-71
	Addenda B	Lineaments and Structures Study - Superior Dacite	Report to J.D.S. 4-26-71
	Addenda C	Geologic Study of Globe-Superior Dist. and Region, plus notes	Report to J.D.S. 5-21-71
Attachments:	A, (Map #2427 + sepia topo overlay)	Interpreted Structural Blocks and elevation of Premineral rock units	Accompanies Summary Report and Addenda B
	B (Map #2435 a&b)	Interpreted Cross-sections for Superior Project Area	Summary Report and Addenda B
	C (Map #2428)	Pumice Ratio Studies, Zonal variations, structures, modified after Plate 4 D.W.P.'s thesis	Addenda A
	D	Superior Dacite Studies-Unmodified copy of Plate 4, D.W.P.'s thesis	Addenda A

	Title	Subject	Where Found
Attachment	E (Map #2451)	Known Structure(s) and Photo-Interpreted Lineaments, Superior Dacite	Addenda B
	F (Map #2452)	Regional Geologic Map, 1:250,000scale	Addenda C
Appendix:	A	D.W.P.'s article in Ariz. Geol. Soc. Guide-book III	Addenda A
	B	Individual's pumice ratio measurements, uncorrected (part 1) and corrected (part 2) data	Addenda A
	C	Combined readings & pumice ratios un-corrected (part 1) and corrected (part 2) data	Addenda A
	D	Ratio Calculations and Calculations Less deletions, data by D.W.P. (Summary given first)	Addenda A
	E	Condensed Copy of Plate 2 from D.W.P.'s thesis, showing ratio changes with depth	Addenda A
	F	Structures in Haunted Canyon and other quadrangles	Addenda B
	G	Work sheets and notes pertaining to district and/or regional study	Addenda C

	Title	Subject	Where Found
Table:	1	Calculated dacite thicknesses and pumice ratios	Addenda A p.p. 6-9
	2	Summary of ASARCO dacite data	Addenda A p.p. 10-12
	3	Interpreted Drill Logs	Addenda B p.p. 3-5
Figure:	1	Plot of Pumice Ratios and zones for Superior dacite vs. height above base of dacite.	Addenda A

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona

April 14, 1971

TO: Mr. W. E. Saegart

FROM: Mr. G. S. Barnett

SUMMARY OF SUPERIOR EAST PROJECT DACITE STUDIES

The purpose of my report is to present the results of three studies undertaken to obtain more information concerning the structure, depth and underlying geology of the dacite or Apache Leap Tuff. These studies are: one, a study of pumice ratios and zonal variations in the dacite mass proper; two, a photogeologic mapping of lineaments; and three, an interpretation of the geologic setting and/or structural blocks for the area.

The pumice ratios (length/width) were studied after preliminary work by D. W. Peterson indicated that these might be of value in determining the relative position of zones in the dacite and were also usuable in calculating depths to the bottom of the dacite. Relative differences of several hundred to possibly one thousand feet can be calculated using flattening ratios. The results of my study indicate that the dacite plateau can be described as an asymmetric syncline with the thickest dacite on the western limb. The axis of this syncline is probably the Devils Canyon drainage with thinner dacite cover to the east and west. The syncline is described as asymmetric because dacite thicknesses were found to be greater to the west of the axis. Measurements were taken in the same locations as those of D. W. Peterson and additional stations were taken to calculate dacite depths and relative displacements across fractures. The results of this study, submitted separately as Addenda A, were then utilized to give dacite depths.

The study of structures within the main dacite mass from Superior to Sutton's Summit (west to east) and from Haunted Canyon to north of Ray (from north to south) was conducted in order to extend previously mapped structures and to map any structure that had not been recognized previously. Areas immediately adjacent to the dacite were studied to determine if any direct correlations might be made between structures exposed adjacent to the main mass and known or inferred structures within the dacite. This study is submitted separately as Addenda B. In addition, the entire region or Globe-Superior district was studied in order to determine if a sequence or pattern of faulting on a district-wide basis could be found. Color photographs and U.S.G.S. mapping were used in this analysis. Notes and maps of this phase are submitted as Addenda C.

It was found convenient to group structures into systems according to their trends. They are as follows:

1) N-75° W ± 10°

2) N-30° W ± 10°

3) N-S ± 15°

4) N-30° E ± 10°

5) N-50° E ± 10°

6) N-60° E

7) N-70° E ± 10°

8) E-W ± 10°

The photogeologic mapping of lineaments in the dacite was completed without an order determined for these fractures. However, subsequent study in the immediate area and adjacent districts allowed an analysis to be completed. It is nearly impossible to infer pre-dacite faulting patterns and/or their significance solely within the dacite mass proper. This had been accomplished as far as possible on the most evident faults by D. W. Peterson as part of his dissertation study. He was the first worker to map numerous faults and zonal variations in the dacite. Using his data, my photogeologic mapping and an extensive review of the regional geology, I have determined blocks within the dacite and also pre-dacite blocks which influenced the evaluation of the structural history of the region. N. P. Peterson described three basic blocks in the Globe-Miami district. My protracted study indicated that four major blocks, or portions thereof, underlie the Superior Dacite. These may be described as the Inspiration block, the Haunted Canyon block, the Pinal Mountains block and the Superior-South block.

As shown on accompanying Attachment A, the premineral basement configuration below the Tertiary units can be described as: 1) A structural ridge with a low saddle in the central part, trending northeast from the Magma Mine to Suttons Summit: 2) A graben-like structural trough extending southward from the vicinity of DCA-3 to past DC-1; 3) Another trough extends, on the north side of the ridge, from the vicinity of OF-1A to past DCA-1.

Included are cross-sections, submitted as Attachment B, used in the preparation of the structural contours shown on Attachment A.

The dacite area can be broken into smaller blocks which are more significant in terms of relative displacements and rock units present. The blocks in the outer (northwestern) areas, away from the Pinal Mountains buttress, generally exhibit a radial pattern of eastward and northeastward tilted blocks, bounded on the northeast and southwest by "tear" faults along which movement in the strike-slip direction is probably greater in magnitude than the normal or

oblique displacements. To the southeast, blocks either tilt eastward or to the south. The faulting sequence is extremely complex and only partially understood by me. However, I have concluded that the ages of faulting for premineral and postmineral rocks is deducible. The Larimide faulting in the area and subsequent displacements are due to tension which developed when vertical uplifts were extant. I have assumed for convenience that this faulting should be catagorized into three groups or peak tectonic periods; the Larimide, Mid-Tertiary and Pasadenan. Additionally, a two-fold separation was made between Earlier Volcanics (Oligocene-Miocene) and Dacite (Miocene) faulting.

The interpretation of the various ages of faulting underneath the dacite must out of necessity rely on an understanding of the geologic history and the description as exposed in adjacent areas.

All systems have had recurrent movements and some fault zones have had later movements only along a position of the entire zone. Different sets have taken precedence in accord to the previously extant patterns and/or rock types present. Many groups have had active faulting and great depths of penetration while fractures in the same system have remained closed and/or shallow in their relative depth of penetration. The following is my interpretation of the structural setting for the area beneath the dacite from the Larimide to present.

In the Larimide (Late Cretaceous to Paleocene-Eocene) and in later epochs, the major structure systems active were:

1) N-75° W $\pm$ 10° system, major en echelon shear zones allowing ingress of igneous materials and subsequent mineralization.

2) N-30° W system, a major normal faulting zone with rotational displacements; available as a conduit for mineralizing solutions.

3) N-S $\pm$ 15° system, a group of predominantly normal faults although with some reverse faults evident. Most active in late Larimide.

4) N-30° E $\pm$ 10° system, also a shearing to normal faulting zone with rotational displacements.

5) N-50° E $\pm$ 10° system, the major deep structures allowing ingress of magmas from approximately 117 million years (Willow Springs Granodiorite) to 64 million (Lost Gulch Quartz Monzonite) years and in Precambrian time (Manitou Granite).

6) The N-60° E system, this direction has been recognized in a number of deposits as of primary importance with regard to mineralization. Actually probably a sub-system to the N-70° E $\pm$ 10° group.

7) N-70° E ± 10° system, this was the major conduit available at the time of the Schultze and Granite Porphyry intrusions beneath the dacite. An en echelon N-70° E group allowed Granite Porphyry intrusion; the N-30° W, N-30° E and especially the N-50° ± 10° E trends were mineralized.

8) E-W ± 10° system, a normal or tensional group in which displacements were secondary adjustments in late Larimide time. Although less active throughout the Earlier Larimide as a tensional feature.

Slightly previous to the mineralization stage (62 M.Y.) the Paleozoic limestones now underneath the dacite were tilting to the east. This tilting continued with the Paleozoics and older units repeated by "normal" faults. The area to the east of Superior was being uplifted and as such, progressively older units were being exposed to the east. The outer zone of Paleozoics and older units is generally 13,000 feet wide (as at Superior) with an inner hinge area averaging 7,000 feet in which Pinal Schist or other Precambrian units were, and are now, exposed. Immediate infilling of the down faulted hinge area began, but blocks were rotated differentially to strip the block units from some areas and deposit them as cover over adjacent blocks. These cover deposits are now the Whitetail Conglomerate.

The turn in the "hinge" area, in the vicinity of Oak Flat, and outer zone was probably a continuously active zone, but became more so at the time of the mid-Tertiary (Early Miocene) volcanism which migrated southeastward along the N-75°W ± 10° system from the Goldfield region to the Haunted Canyon area; and related to this volcanism, a major N-30° E ± 10° trending block trough was formed in the northwestern part of the main dacite mass. The north to south graben which extends nearly to Ray, Arizona was receiving significant Whitetail Conglomerate accumulations, but some blocks in the inner portion of the fringe zone continued to be eroded and weathered.

Bounding faults, as such, are rather indistinct at times in the outer zone with major displacement having taken place along numerous fractures. The N-30° W and N-30° E fault groups were most active in the Early Miocene times with the latter phase of tectonism exhibiting north to south tensional features (major normal faulting with some rotation).

The Pasadenan (last 10 or 5 million years to present) has established the faulting pattern now evident in the Globe-Superior area and post-dacite thrusting has been recognized to have had major significance (up to 10(?) miles). Thrusting on a smaller scale is also probable in the Larimide and Early Miocene events.

Mid-to-late Miocene volcanism extruded the dacite over a terrain of high relief which to the north of Suttons Summit was essentially devoid of a Whitetail cover. To the northwest this cover increases to 265 feet, in DCA-2, downdip on the block surface. The dacite can rest on Earlier Volcanics, Volcanic Conglomerate, Basaltic andesite or Whitetail Conglomerate depending on the relative depths of erosion in pre-dacite times.

Later displacements have either elevated the entire dacite plateau and/or down dropped adjacent areas. These downdrops may be described using the same

systems used for an explanation of Larimide events (as can the mid-Tertiary events). However, the fault pattern extant modified the stress orientations and strain to conform with the pre-established patterns.

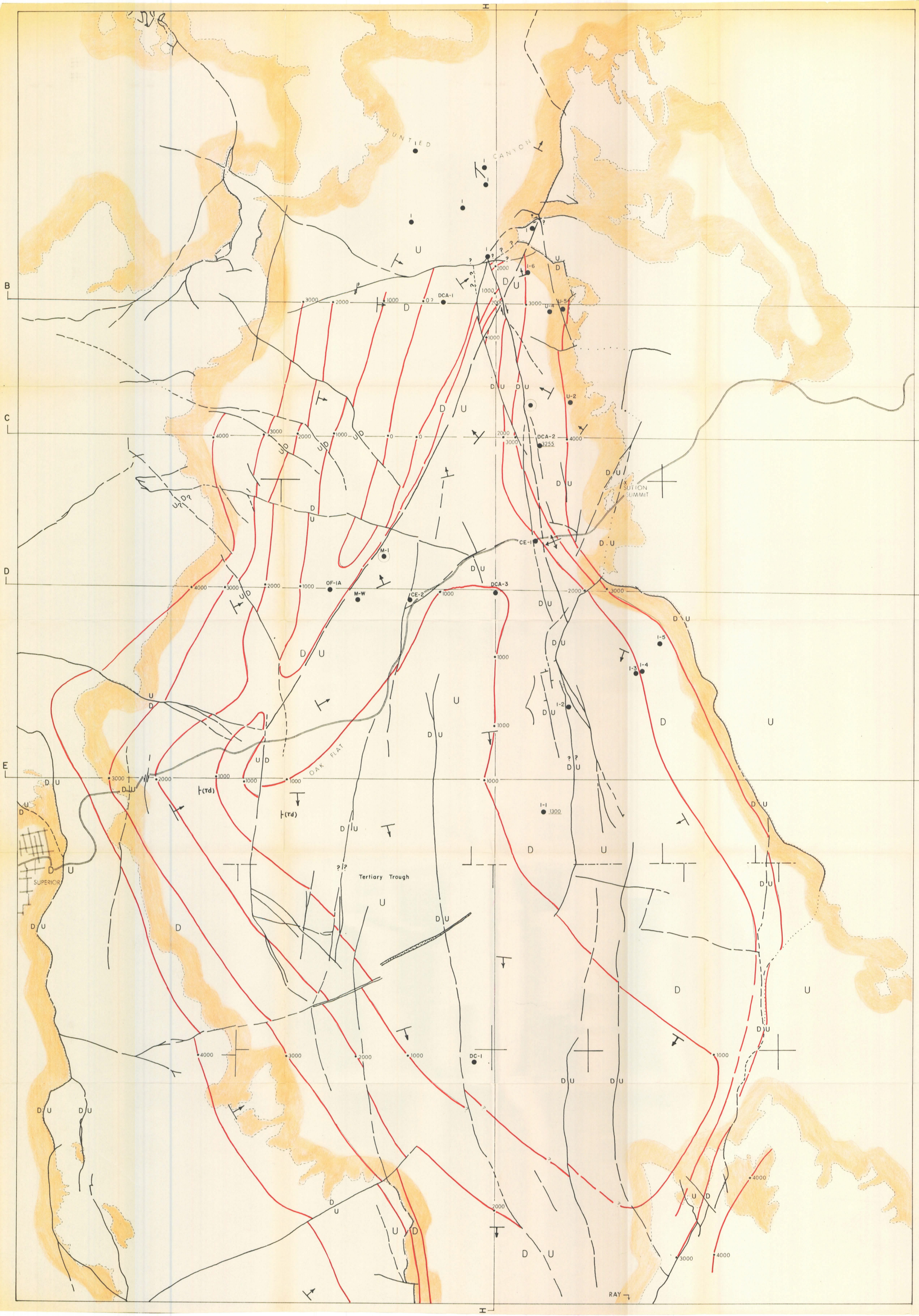
Dip and strike symbols used on Attachment A refer to the strike and dip of structural blocks underlying the dacite. Large "Us" and "Ds" refer to the relative degree of uplift which has affected rock units underlying Tertiary rock units. Small down and up symbols (D and U) refer to the relative displacement on faults in the dacite.

I would recommend that holes M-1, be re-entered and deepened to premineral rocks. M-1 is near to a major tensional site and also near to the projected nose of Schultze Granite (James D. Sell, ASARCO, Superior East Project Geologic Map). M-1 bottomed in basaltic andesite and may encounter a thin (0-100') devitrified quartz latitic tuff and Whitetail Conglomerate before reaching premineral units. The Whitetail Conglomerate is extremely variable in thickness but it should reach only about 200' if N-S faulting in the N-S trending graben did not downdrop this area greatly. A new hole should be drilled in unsurveyed Sec. 11, T 1 S, R 13 E, 4,000 feet north of the north section line of Sec. 14, T 1 S, R 13 E, and 2,000 feet west of the section line between sections 11 and 12, to test for the extension of the mineralization which is found to the east of the dacite at a lower elevation.

George S. Barnett

George S. Barnett

GSB:bb
cc: JDSell



ATTACHMENT A

TO ACCOMPANY REPORT SUMMARY
DATED APRIL 14, 1971
BY G.S. BARNETT

N
B
B'
C
C'
D
D'
E
E'
H
H
UNTIED
CANYON
SUTTON SUMMIT
OAK FLAT
SUPERIOR
Tertiary Trough
RAY
DCA-1
DCA-2
DCA-3
CE-1
CE-2
OF-IA
M-W
M-1
U-2
U-4
U-5
I-1
I-2
I-3
I-4
I-5
I-6
DC-1
1255
1300
1000
2000
3000
4000
0
0?
(Td)
D
U
D U
U D
U?D?
? ?

EXPLANATION

D/U	LARGE D & U (DOWN & UP) USED FOR RELATIVE ROCK UNITS EXPOSED ON BLOCK SURFACES
D/U	SMALL D & U USED TO INDICATE MOST RECENT DISPLACEMENTS IN DACITE
—	INFERRED BOUNDING FAULTS
⊥	INFERRED STRIKE AND DIP DIRECTION OF BLOCKS
⁄	CONTOURS ON INFERRED ELEVATION ABOVE SEALEVEL OF PREMINERAL ROCKS
1000 •	DOT USED FOR CONTROL POINTS ELEVATION
●	DRILL HOLES
◉	PROPOSED DRILL HOLES
▨	OUTLINE OF TERTIARY COVER (PREDOMINATELY DACITE)

I MILE

INTERPRETED STRUCTURAL BLOCKS AND ELEVATION OF PREMINERAL ROCKS

SUPERIOR EAST PROJECT

GLOBE-SUPERIOR DISTRICT

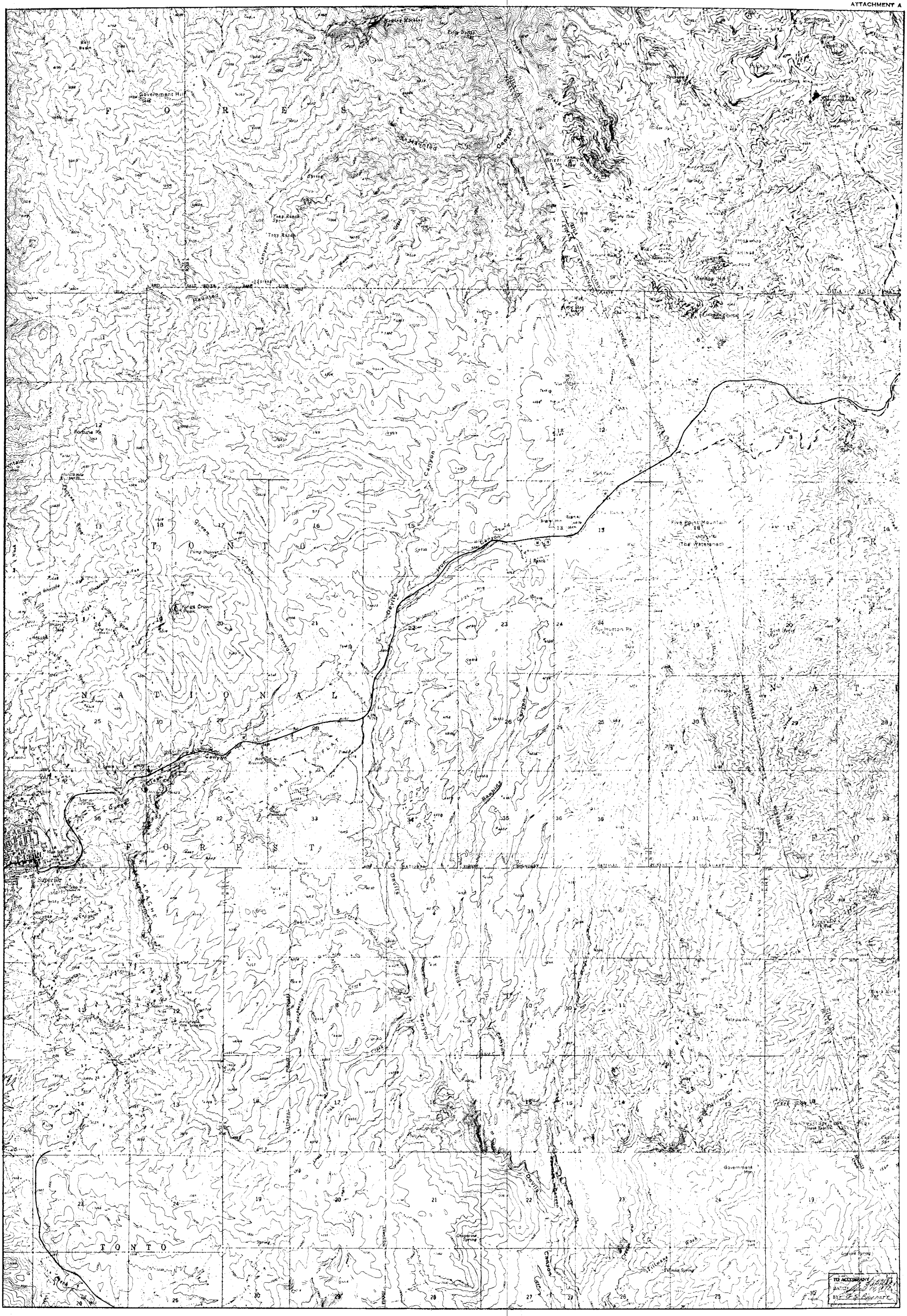
Pinal & Gila Counties, Arizona

SCALE 1:24000

G.S.B

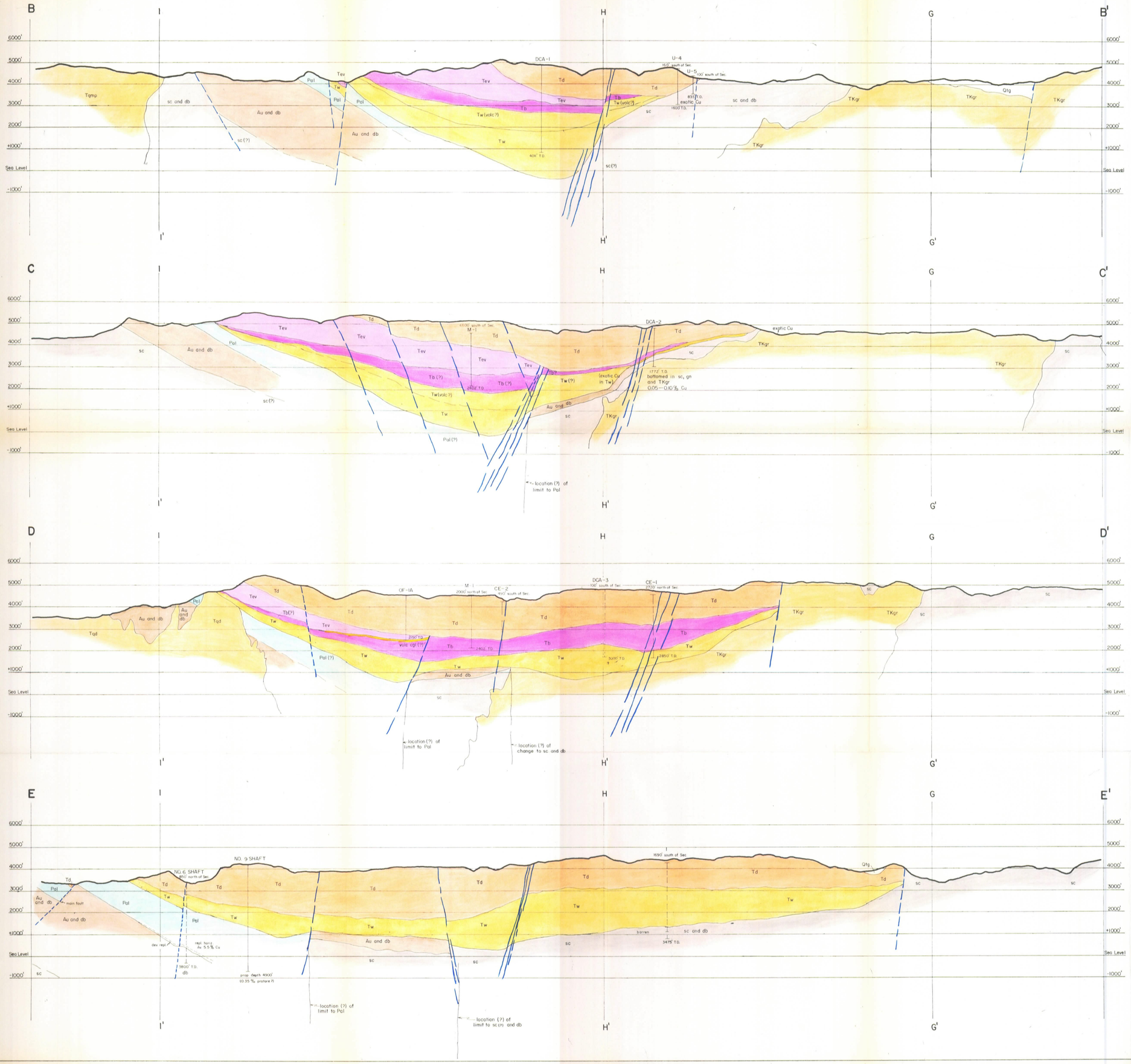
April 1971
2427

ATTACHMENT A



OVERLAY FOR MAP 2427

ATTACHMENT B



EXPLANATION

QUATERNARY

- Qtg — Gila conglomerate

TERTIARY

- Td — Dacite (20 m.y.)
- Tev — Earlier volcanics (rhyolites, latites, glasses, vent units, etc.)
- Tvc — Volcanic conglomerate (weathered surface(s) or tuffaceous conglomerates)
- Tb — Basalt or basaltic andesite (previously not differentiated from Tev)
- Tw — Whitetail conglomerate (includes some Tvc units)

LARAMIDE

- TKgr — Schultze granite (63 m.y.) and other intrusives (Tqmp, Tqd)

PALEOZOIC

- Pal — Sedimentary rocks

YOUNGER PRECAMBRIAN

- db — Diabase (1140 m.y.)
- Au — Apache group

OLDER PRECAMBRIAN

- sc — Pinal schist

Inferred locations for major rock type changes

Faults

MODIFIED AFTER J.D. SELL, JUNE 1970

TO ACCOMPANY SUMMARY
DATED APRIL 14, 1971
BY G.S. BARNETT

EAST, WEST SECTIONS

(looking north)

SUPERIOR EAST PROJECT

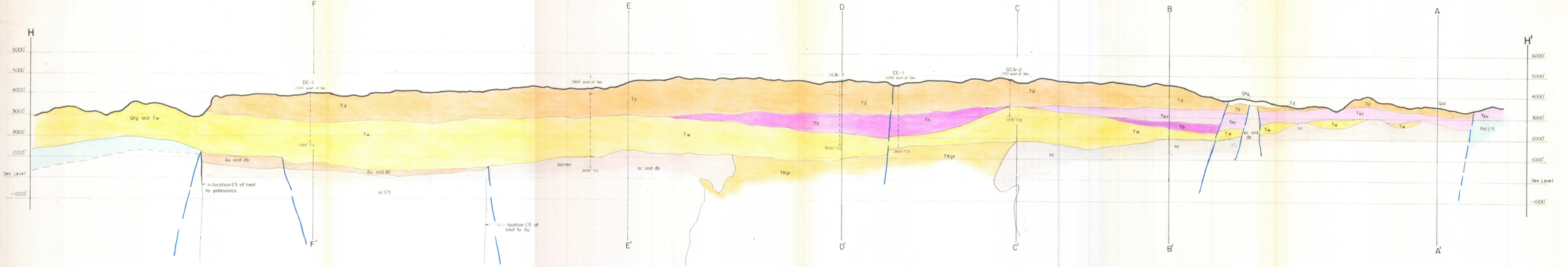
Pinal County, Arizona

SCALE: 1" = 2000'

G.S.B. APRIL, 1971

2435a

ATTACHMENT B



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- TKgr — Schultze granite (63 m.y.) and other intrusives (Tqmp, Tqt)

PALEOZOIC

- Pzl — Sedimentary rocks

YOUNGER PRECAMBRIAN

- db — Diabase (1140 m.y.)
- Au — Apache group

OLDER PRECAMBRIAN

- sc — Pinal schist

Inferred locations for major rock type changes

Faults

MODIFIED AFTER J.D. SELL, JUNE 1970

TO ACCOMPANY REPORT SUMMARY
DATED April 14, 1971
BY D. S. Cockett

NORTH, SOUTH SECTION
(looking west)

SUPERIOR EAST PROJECT

Pinal County, Arizona

SCALE: 1" = 2000'

G.S.B. April, 1971

2435 b

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Attachment E (Map 2451) Plot of known and photo-interpreted structures in the dacite and adjacent areas
Table 3 (In text) Interpreted drill logs
Appendix F Structures and their importance (in portions of the Haunted Canyon, Superior, Inspiration, Pinal Ranch and Globe Quadrangles) for the N45-55° ± 10°E system

Addenda C

Attachment F
Appendix G

LIST OF REPORTS, ATTACHMENTS, APPENDICES, ETC.
FOR THE SUPERIOR EAST PROJECT

	Title	Subject	Where Found
Reports:	Summary of Superior East Project, Dacite Studies	Summary of Studies	Report to W.E.S. 4-14-71
	Addenda A	Superior dacite, pumice flattening ratios, thickness estimates and zones	Report to J.D.S. 4-20-71
	Addenda B	Lineaments and Structures Study - Superior Dacite	Report to J.D.S. 4-26-71
	Addenda C	Geologic Study of Globe-Superior Dist. and Region, plus notes	Report to J.D.S. 5-21-71
Attachments:	A, (Map #2427 + sepia topo overlay)	Interpreted Structural Blocks and elevation of Premineral rock units	Accompanies Summary Report and Addenda B
	B (Map #2435 a&b)	Interpreted Cross-sections for Superior Project Area	Summary Report and Addenda B
	C (Map #2428)	Pumice Ratio Studies, Zonal variations, structures, modified after Plate 4 D.W.P.'s thesis	Addenda A
	D	Superior Dacite Studies-Unmodified copy of Plate 4, D.W.P.'s thesis	Addenda A

	Title	Subject	Where Found
Attachment	E (Map #2451)	Known Structure(s) and Photo-Interpreted Lineaments, Superior Dacite	Addenda B
	F (Map #2452)	Regional Geologic Map, 1:250,000scale	Addenda C
Appendix:	A	D.W.P.'s article in Ariz. Geol. Soc. Guide-book III	Addenda A
	B	Individual's pumice ratio measurements, uncorrected (part 1) and corrected (part 2) data	Addenda A
	C	Combined readings & pumice ratios un-corrected (part 1) and corrected (part 2) data	Addenda A
	D	Ratio Calculations and Calculations Less deletions, data by D.W.P. (Summary given first)	Addenda A
	E	Condensed Copy of Plate 2 from D.W.P.'s thesis, showing ratio changes with depth	Addenda A
	F	Structures in Haunted Canyon and other quadrangles	Addenda B
	G	Work sheets and notes pertaining to district and/or regional study	Addenda C

	Title	Subject	Where Found
Table:	1	Calculated dacite thicknesses and pumice ratios	Addenda A p.p. 6-9
	2	Summary of ASARCO dacite data	Addenda A p.p. 10-12
	3	Interpreted Drill Logs	Addenda B p.p. 3-5
Figure:	1	Plot of Pumice Ratios and zones for Superior dacite vs. height above base of dacite.	Addenda A

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona

April 20, 1971

ADDENDA A

TO: J. D. Sell

FROM: G. S. Barnett

Re: SUPERIOR DACITE (PUMICE FLATTENING RATIOS, THICKNESS ESTIMATES AND ZONES)

In general, the dacite mass may be described as a very nearly a plateau with relatively moderately dipping planar structures which may represent flowage planes and/or joints. Dips can range from zero degrees to about sixty degrees. An average would probably be from 10°-15°. Hereafter the "dacite" will be used to describe the entire mass between Superior and Pinal Ranch from west to east, and from Haunted Canyon to north of Ray, from north to south.

A study of the ratio of length to thickness for pumice fragments was conducted in the dacite. This study was conducted after the initial studies by D. W. Peterson (Peterson, 1961 and 1968) which indicated that this might be a valuable technique for determining thicknesses of ash-flows. The reader may refer to these publications for further information or to an excellent discussion of the entire dacite complex (attached as Appendix A).

Pumice fragments may be often recognized by a pumiceous texture which at times shows the encroachment of crystallization in a portion or majority of the fragment. Of special note in Peterson's description of pumice fragments is the observation that "many of the phenocrysts in the enclosing rock (matrix) are broken, whereas they are generally unbroken in the pumice fragments."

Along road cuts or in recently broken boulders, the pumice fragments show up as bright, white lenticular to ovoid inclusions in a darker-brownish matrix. The outlines of these fragments range from well defined to very poorly defined, depending upon degree of devitrification and/or vapor phase crystallization.

Of note also, is the rather distinct parallelism of the pumice fragments with relatively few fragments setting at oblique angles. No fragments were observed with a long axis vertical.

The dacite is found to consist of from zero percent to very nearly one hundred percent pumice fragments in certain areas. The impression I was given was,"that the dacite can best be described as a lapilli-flow with the matrix secondary to pumice fragments, with a matrix possibly being derived from autobrecciation of flowing fragments and fluids". Pumice fragments

are not recognizable in the lower-most nonwelded tuff unit of the dacite, below the vitrophyre, nor are pumice fragments observable in the vitrophyre or basal portion of the brown unit. This is due to their extreme flattening rather than to their absence. The upper portion of the brown unit contains numerous pumice fragments although their extreme flattening causes some difficulty in recognition. The pumice fragments become progressively less flattened as one goes "up section" in the dacite and therefore the abundance of fragments seems to increase. Pumice fragments in the uppermost portions of the white unit are very difficult to delimit making their measurement tedious as well as tenuous.

The pumice fragments were measured using a six-inch plastic scale. A felt-tip pen was used as much as possible to mark those fragments measured for future reference and more to be sure that the same fragments were not measured more than once.

Measurements were recorded in a standard field book to be later transferred to IBM coding sheets for data reduction.

A program was written by Mr. Dave Sims and entitled ASARCO Dacite program. The data was coded using the following format:

The number one card is an identification card with columns:

2- 8 Used for station

11-35 Station name, abbreviation and number

36-48 Date: XX-XX-XX

51-80 Recorder name

The rest of the cards are used for data. The program has been set up to calculate ratios from either recorded measurements (A = length; B = height, see Appendix A or B) or ratios previously determined.

Columns: 6-10 = XX.XX length

16-20 = XX.XX width

26-30 = XX.XX ratios

36-80 identification--abbreviations, dates, etc.

Two trailing cards signify end of data.

The data cards were run initially to locate cards in error. Then another run was made using corrected data only. The results of both of these runs are collected as Appendices B and C. These data were then tabulated and the results included in the above mentioned appendices.

One highly significant fact became apparent upon comparing the data, which included few to numerous errors, to Peterson's ratios and the

corrected copy of the dacite data. The data with errors at times agreed much more closely with Peterson's work than did the corrected data. The errors which were corrected were generally quite high ratio values. Therefore, I surmised that my error had been in the non-recognition of those well flattened pumice fragments which would give a very different ratio. Attempting to verify whether or not this was the case, I submitted Dr. Peterson's ratio determinations on separate runs, each time eliminating the two highest ratios. The results were tabulated as follows:

Summary Sheet-Ratio Calculations
and Calculations Less Deletions
Data by Dr. D. W. Peterson

Approximate Distance to Dacite Base	Station	Ratio	Minus 2	Minus 4	Minus 6	Minus 8
1980 ft.	OF-1	1.224	--	--	--	--
1820 ft.	SHA-15	1.683	--	--	--	--
1610 ft.	SHA-13	2.000	--	--	--	--
1590 ft.	SHA-12	2.720	--	--	--	--
1450 ft.	SHA-11	3.294	2.952	2.790	--	--
1300 ft.	SHA-10	4.969	4.595	4.307	4.174	--
1075 ft.	SHA-9	8.931	6.936	6.023	5.652	5.460
690 ft.	SHA-7	24.087	21.06	19.915	18.749	17.683

Of greatest significance are the changes that occurred in the data for station SHA-7. This station was the lowermost in the dacite mass and the ratio changed approximately 1.00 for each high value deleted.

Therefore, it is very apparent that those fragments having extremely high flattening ratios have a very significant end result on the total ratio determination for the lower zones in the dacite. However, very thin pumice fragments are rare to absent from the upper portion of the gray unit in the dacite and upwards into the white unit. As such, this factor is not significant for a large portion of the dacite.

Sites were selected to check the ratio determinations of Dr. Peterson and to obtain additional ratios. These sites and those of Dr. Peterson are shown on Attachment C (after Plate 4, Dr. Peterson's dissertation). Additionally, Attachment C shows the locations of stations suggested to the author as valuable for further ratio determinations.

Station measurements are recorded in Appendices B and C. Appendix B contains the results of each station's measurements (uncorrected and corrected) as recorded by different individuals. Mr. Ramon Shannon and Mr. James Sell assisted me in the measurement and/or recording of data at different stations.

This data serves to indicate the variance which can occur when different individuals measure pumice fragments.

Appendix C contains the combined totals of all measurements made at a station and the computer's calculation of a flattening ratio. The final pumice flattening ratio for both the corrected and uncorrected data is included. Dacite thicknesses were calculated using these data and those shown on Dr. Peterson's map. For all calculations, ratios were referred to profile SHa, Appendix E, (Plate 2, D. W. Peterson's Doctoral Dissertation), unless otherwise noted (see SS-1, third depth calculation).

It is possible that pumice ratios do not apply to the entire dacite mass, but rather to that thickness which contains discernible pumice fragments. If this is the case, then variances of several hundred feet will be noted in calculated dacite thicknesses. Measurements at known drill sites can be used to indicate the degree of certainty one is justified in attaching to ratio determinations for various areas of the dacite. There is also an additional source of error as shown by Figure 1, in that reference profiles must be available near measurement stations.

The following are notes for the stations shown in Table 1 and on the summary sheet, Table 2.

Shaft station SH-1 was located in SE-1/4, Sec. 25, T 1 S, R 12 E. SH-2 and SH-3 were, respectively, 100 feet and 500 feet east as approximately the same elevation.

Shaft #1, SH-1, measurements were taken in order to determine a ratio well away from the fault zone.

Shaft #2 and 3, SH-2 and SH-3, were taken as nearly as possible at the same locations as were Dr. Peterson's stations. When calculated, these data first pointed out the need for an accurate and exhaustive measurement of very thin pumice fragments. All measurements were made in the gray unit of the dacite.

Sutton's Summit ratios were also taken near D. W. Peterson's measuring stations. SS-1 is in NE 1/4, Sec. 14, T 1 S, R 13 E; SS-2 and SS-3 are about 200 feet and 500 feet east respectively. A north-south fault brings the gray unit up on the east side against the white unit. Ratio changes were very evident as were unit or zonal changes. RatioSS-1 in particular gave a calculated result very near to the inferred value obtained from averaging thicknesses from the two closest drill holes. SS-2 and SS-3 were compatible to the relations observed in the field and shown on Dr. Peterson's mapping.

Jl-Ranch #'s 1 and 2, Jl-1 and 2, were taken at stations very closely, if not exactly, those shown by Dr. Peterson in the NW 1/4, SE 1/4, Sec. 23, T 1 S, R 13 E. Ratios and calculated depths were not comparable to those obtained by Dr. Peterson. I do not know the reason for this, but, because Dr. Peterson's data is closer to the values obtained in CE-1, I used his ratios for calculations. Both stations are in the white unit.

OF-1 is located in S 1/2, Sec. 29, T 1 S, R 13 E, with OF-2

TO ACCOMPANY REPORT
DATED 4/20/71
BY F.S. BRINETT

PLOT of ZONES and PUMICE RATIOS for SUPERIOR DACITE

APPROX. DEPTH OF DACITE

HEIGHT ABOVE BASE

SHa DEPTH	SHa MEAN	SHa COLOR	DC-14 DEPTH	DC-14 MEAN	DC-14 COLOR	EDa DEPTH	EDa MEAN	EDa COLOR	JKc DEPTH	JKc MEAN	JKc COLOR	EC DEPTH	EC MEAN	EC COLOR	SS DEPTH	SS MEAN	SS COLOR
1980	1.3	WHITE				2000	2.075	WHITE									
						1910	2.50	WHITE									
1820	1.7	WHITE				1815	3.60	WHITE									
						1730	3.75	GRAY									
						1680	4.25	WHITE									
1610	1.9	WHITE				1610	4.075	TRANS.									
1590	2.9	WHITE															
						1550	4.90	GRAY									
						1500	5.35	GRAY									
1450	3.3	WHITE															
1300	5.0	GRAY															
1075	9.0	GRAY															
			900	4.8	WHITE												
												860	3.25	WHITE			
			750	6.5	GRAY												
690	20.3	BROWN							670	2.075	WHITE	725	4.00	TRANS.	700	4.10	GRAY
												620	5.40	GRAY			
			585	8.0	GRAY												
									530	2.50	WHITE						
			410	24.0	GRAY				4.25	3.60	WHITE	400	8.30	BROWN			
									370	6.00	GRAY						
			270	42.0	GRAY										260	15.06	GRAY
					BROWN				100	14.0	TRANS. TO BROWN						

FIGURE I.

G.S.B. MARCH 1971

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about 300 feet east and OF-3 about 500 feet north and 500 feet east. No significant ratio changes were found.

Throw, 235-1 and 235-2, were taken approximately 1000 feet south and 100 feet apart to attempt to confirm a ratio change across the fault indicated on Dr. Peterson's map, (Plate 4), Attachment D, this report. The ratio changes, obtained by me, were not significant. However, subsequent study indicated that the fault was plotted about 100 feet farther west than the true location. OF-1, 2, and 3 and 235-1 and 2 are all in the white unit.

Creek, CRK-0, 1, 2A and 2B, are all located along a fault shown on Attachment D in S 1/2, SE 1/4, Sec. 27, T 1 S, R 13 E. Crk-0 was measured about 250 feet west of the fault trace while Crk-1 and Crk-2 were measured on the west and east sides of the fault respectively. Crk-2A and 2B were measured along a different joint-face set to check for ratio dependence on the direction of the exposed surface. The differences are not considered significant.

Ruff Slope, RS-1 and 2, are located about 1500 feet north of Crk stations. The fact that no ratio changes were measured may indicate that the fault shown has had a scissors-like displacement with the northern portion of the fracture displaced little, if at all. The displacement may continue to increase southward. A decrease in displacement even farther south, would indicate a "sag" type of movement along this fault.

Sum Bank #1 and 2, SB-1 and 2, located about 2000 feet east of the Crk stations, were taken to measure the relative displacement and/or significance of a northwesterly trending, photo-interpreted fracture. SB-1 and2 indicated that displacement calculations must also take into consideration and differences in elevation between stations; i.e., that ratio must be compared on a horizontal reference plane to determine approximate throw across a fault.

Tank #1 and 2, TK-1 and 2, stations are located in the E 1/2, SE 1/4, Sec. 21, T 1 S, R 13 E. These measurements were completely in the white unit and show approximately 170' of throw along a northwesterly (N 75°W) trending fault.

Power line, PL-1 and 2, were taken south and north, respectively, of a photo-interpreted fault. The ratio and therefore calculations based upon it, is suspect due to the very poor exposures of pumice fragments at station PL-2. The stations were both in the gray unit, located in the W 1/2, SW 1/4, Sec. 16, T 1 S, R 13 E.

Devil's Canyon East, DCE-1A, 1B, 1C, 2C, 2B and 2A, were taken to determine vertical variations in ratios across a canyon from edge to edge. The canyon is thought to represent a northwesterly trending fault. The ratios indicated a reversal (ratio decrease) in ratios as determined down section from 1A to 1B to 1C and up section from 2C to 2B to 2A. Stations with the same letter label were taken at approximately the same elevation to aid in relative displacement calculations.

DCE-3 and 4 were measured 300 feet and 700 feet east of DCE-2A,

respectively. In addition, DCE-4 was approximately 60 feet higher than DCE-2 or 3, so this had to be subtracted from the depth of the dacite in order to have all measurements referred to the same plane.

DCE-5, was measured about 600 feet south of DCE-4 to check for a ratio change across the fault.

TABLE ONE

CALCULATIONS OF DACITE THICKNESSES

	Station	Depth	Source of Information
Shaft	SH-1	775?	Shaft #6 and underground workings of Magma Mine.
		1290'*	G.S.B. Pumice Ratio referred to "SHa" profile. Uncorrected ratio used as nearest to "true" value.
Shaft	SH-2	750'	Shaft #6, etc.
		1190'*	G.S.B. uncorrected pumice ratio = DWP pumice ratio.
Shaft	SH-3	550'	Shaft #6, etc.
		980'	GSB uncorrected pumice ratio
		1010'*	DWP pumice ratio
Suttons Summit	SS-1	1413'	Estimated from drill holes: CE-1 - 1555' dacite DCA-2 - 1270'? dacite DCA-3 - 1490' dacite $\frac{4315}{3}$ = 1438' ave. dacite depth (3 holes) $\frac{1555 + 1270}{2}$ = 1413' ave. dacite depth (nearest 2 holes)
		1410'*	GSB pumice ration (SH curve)
		1790'	GSB pumice ratio (EDa curve)
Sutton's Summit	SS-2	1413'	Same as SS-1
		1360'*	GSB corrected pumice ratio
		1355'	GSB uncorrected pumice ratio
		1590'	DWP pumice ratio

*Used to indicate value considered closest to "true" value.

	Station	Depth	Source of Information
Sutton's Summit	SS-3	1413'	Same as SS-1
		1210'	GSB pumice ratio
		1245'*	DWP pumice ratio
JI Ranch	JI-1	1523'	DCA-3 = 1490' dacite intercept interpreted depths from drill logs CE-1 = 1555' dacite intercept Combined dacite depth level $\frac{3045}{2} = 1523'$ Ave. dacite depth
		1260'	GSB pumice ratio
		1585'*	DWP pumice ratio
JI Ranch	JI-2	1523'	Same as JI-1
		1340'	GSB pumice ratio
		1390'*	DWP pumice ratio
Oak Flat	OF-1	1875'	Shaft #9, Magma Mine dacite depth 3500' E of station
		1618'*	GSB-JDS pumice ratio
Oak Flat	OF-2	2000'	Same as OF-1
		1600+'*	GSB-JDS pumice ratio
Oak Flat	OF-3	2000'	Same as OF-1
		1590'*	GSB-JDS pumice ratio
Throw	235-1	2000'	Same as OF-1
		1585'*	GSB-JDS pumice ratio
		1590'	DWP pumice ratio
Throw	235-2	2000'	Same as OF-1
		1595'	GSB-JDS pumice ratio
		1315'*	DWP pumice ratio
			Note: Fault missed by GSB-JDS pumice ratio, I assumed DWP's pumice ratio was taken across fault.

*Used to indicate value considered closest to "true" value.

	Station	Depth	Source of Information
Creek	Crk-0	1400+'?	DCA-3 (1490' dacite)
			DC-1 (1165' dacite)
		1440'*	GSB pumice ratio
Creek	Crk-1	1400+'?	Same as Crk-0
		1375'*	GSB pumice ratio
		1360'	DWP pumice ratio
Creek	Crk-2	1400+'?	Same as Crk-0
	-2A	1330'	GSB pumice ratio
	-2B	1370'	GSB pumice ratio
	-2(A & B)	1350'*	GSB pumice ratio
		1190'*	DWP pumice ratio (further east of fault?)
Ruff Slope	RS-1	1400+'?	Same as Crk-0
		1395'*	GSB uncorrected pumice ratio
Ruff Slope	RS-2	1400+'?	
		1415'	GSB uncorrected pumice ratio
			Note: Uncorrected pumice ratios were used to check differences obtained. Ratios are actually not significantly different.
Sum Bank	SB-1	1400'	Same as Crk-0
		1270'*	GSB pumice ratio
Sum Bank	SB-2	1400+'	Same as Crk-0
		1385'*	GSB pumice ratio
Tank	TK-1	2000'	Eda curve DWP
		1610'*	GSB pumice ratio
Tank	TK-2	2000'	Same as TK-1
		1440'*	GSB pumice ratio

*Used to indicate value considered closest to "true" value.

	Station	Depth	Source of Information
Power Line	PL-1	1500+'	Estimated (GSB)
		1435'*	GSB pumice ratio
Power Line	PL-2	1500'	Estimated (GSB)
		1180'*	GSB pumice ratio
Devil's Canyon East	DCE-1A	2000'	Estimated (GSB)
	-1A (2.91)=1570'		GSB pumice ratio
	-1B (3.00)=1545'		GSB pumice ratio
	-1C (2.76)=1580'		GSB pumice ratio
	-1A=(A+B+C)=1575'*		GSB pumice ratio
Devil's Canyon East	DEC-2A	2000'	Estimated (GSB)
	-2A (3.17)=1500'		GSB pumice ratio
	-2B (3.08)-1520'		GSB pumice ratio
	-2C (2.89)-1575'		GSB pumice ratio
	-2A=(A+B+C)-1530'*		GSB pumice ratio
Devil's Canyon East	DCE-3	2000'	Estimated (GSB)
		1535'*	GSB pumice ratio
Devil's Canyon East	DCE-4	2000'	Estimated (GSB)
		1355'*	GSB pumice ratio
Devil's Canyon East	DCE-5	2000'	Estimated (GSB)
		1470'*	GSB pumice ratio

*Used to indicate value considered closest to "true" value.

TABLE 2

SUMMARY ASARCO DACITE DATA

Combined Totals - Pumice Ratio Determinations

STATION	RATIO	DWP'S RATIO	UNCORRECTED RATIO	CALCULATED DEPTH OF DACITE	REASON MEASURED LOCATION, ZONE, SIGNIFICANCE
SH-1	5.08		5.08	1290'	Check ratio change near fault.
SH-2	4.34	6.91	6.92*	1190'	Check ratio change in fault zor
SH-3	5.43	10.37	10.98*	1010'	Check ratio across fault.
DIFFERENCE				180'	Probable displacement.
SS-1	3.78*		3.68	1410'	Check ratio change approaching fault.
SS-2	4.28*	2.48	4.31	1360'	Check ratio change west side of fault.
SS-3	6.23	5.74	6.23	1245'	Check ratio change east side of fault.
DIFFERENCE				245'	Probable displacement, plus sta tion's 80' elevation differenc
JI-1	5.64*	2.56	5.64	1585'	Check ratio change west of fault.
JI-2	4.43*	3.96	4.44	1390'	Check ratio change east of fault.
DIFFERENCE				195'	Probable displacement.
OF-1	2.10		2.11	1618'	Determine ratio Oak Flat area west of fault.
OF-2	2.35		2.13	1600'	Determine ratio Oak Flat area east of fault. Note: Missed fault area?
OF-3	2.47*		2.47	1590'	Determine ratio Oak Flat area east of fault. Note: Missed fault?
DIFFERENCE				28'	Inferred change (out of accuracy limits of ratios?).
235-1	2.56*	2.54		1590'	Determine ratio west of fault.
235-2	2.45*	4.69		1595'	Determine ratio east of fault (missed?).
DIFFERENCE				----	

*Used to indicate value considered closest to "true" value.

Underlined ratio used in depth calculations.

TABLE 2

SUMMARY ASARCO DACITE DATA

Combined Totals - Pumice Ratio Determinations

STATION	RATIO	DWP'S RATIO	UNCORRECTED RATIO	CALCULATED DEPTH OF DACITE	REASON MEASURED LOCATION, ZONE, SIGNIFICANCE
		4.69		1315'	Assumed DWP's measurements were taken cross fault.
DIFFERENCE				275'	
CRK-0	3.45*		3.44	1440'	150' west of fault zone.
CRK-1	4.12*	4.35	4.10	1360'	Adjacent to fault zone, west side.
CRK-2A	4.59*	6.59	4.54	1330'	To show variance of ratio with direction of surfaces pumice fragments measured on.
CRK-2B	4.15*	6.59	3.31	1350'	
CRK-2(A+B)	4.38*	6.59		1350'	To give total ratio east of fault.
DIFFERENCE				90'	
		6.59		1190'	May be dacite depth farther east.
DIFFERENCE				250'	Note: Fault may be farther east
RS-1	3.77		3.90*	1395'	Used uncorrected values to show error in depth determinations using uncorrected data.
RS-2	3.77		3.74*	1415'	
DIFFERENCE	0.00			- 20'-	No actual change measured.
SB-1	5.42*		5.42	1270'	South side; Check ratio change across minor fracture.
SB-2	4.01*		4.10	1385'	North side; Check ratio change across minor fracture.
DIFFERENCE				55'	Probable displacement minor.
TK-1	2.23*		2.23	1610'	South side of inferred fault to check ratio change across it.
TK-2	3.45*		3.40	1440'	North side of fault?
DIFFERENCE				170'	Probable displacement.

*Used to indicate value considered closest to "true" value.
Underlined ratio used in depth calculations.

TABLE 2

SUMMARY ASARCO DACITE DATA

Combined Totals - Pumice Ratio Determinations

STATION	RATIO	DWP'S RATIO	UNCORRECTED RATIO	CALCULATED DEPTH OF DACITE	REASON MEASURED LOCATION, ZONE, SIGNIFICANCE
PL-1	3.55*		3.55	1435'	South side of inferred fault to check ratio change.
PL-2	6.69*		6.69	1180'	North side of fault?
DIFFERENCE				255'	Probable displacement? weighted
DCE-1A(A+B+C)	2.89*		2.89	1575'	Southside of canyon to check ratio change across inferred fault.
DCE-1A	2.91			1570'	Check ratio change as measured down section.
DCE-1B	3.00			1545'	
DCE-1C	2.76			1580'	
DCE-2A(A+B+C)	3.05*		3.05	1530'	Same as DCE-1A(A+B+C) for north side of canyon.
DCE-2A	3.17			1500'	Same as DCE-2A, 2B
DCE-2B	3.08			1520'	Same as DCE-2C.
DCE-2C	2.89			1575'	
DIFFERENCE				45'	Not significant.
DCE-3	3.04*		3.04	1535'	Check lateral change in ratio.
DCE-4	4.32*		4.32	1355'	
DIFFERENCE				180'	Significance indeterminate.
DCE-4	4.32*		4.32	1355'	(Lateral change or fault?) (may be as great as 260') To check ratio change across fault station on north side.
DCE-5	3.30*		3.30	1470'	Check ratio change across fault station on south side
SIFFERENCE				115'	Throw(?) along NW trending fault.

*Used to indicate value considered closest to "true" value.
Underlined ratio used in depth calculations.

Dacite units or zones have been mapped by D. W. Peterson as part of his doctoral dissertation problem. Additional mapping, at a smaller scale, is included in his paper, Zoned Ash-Flow Sheet in the Region Around Superior, Arizona (Arizona Guidebook III, 1968, p. 218) included in Appendix A, this report. I did not expand upon Dr. Peterson's mapping except to familiarize myself with it and to verify portions of his mapping. Additionally, preliminary notes of units exposed along the drill road to drill site, DC-1 (N 1/2, NE 1/4, Section 16, T 2 S, R 3 E), are indicated on Attachment C. The reader is referred to the above mentioned article or Dr. Peterson's Dissertation (Dacitic Ash-flow near Superior and Globe, Arizona: Stanford University, Stanford, California, PHd. Thesis, 130 pgs.; U.S. Geol. Survey open file report, April 3, 1961) for further information. Also of great aid in the recognition of zones in pyroclastics is Zones and Zonal Variations in Welded Ash-Flows: U. S. Geol. Survey, Prof. Paper 354-F.

Attachment C includes the mapping of Dr. D. W. Peterson for his Ph.D. and a compilation of the additional mapping shown in Arizona Guidebook III. My additions consist of more pumice flattening ratio plots and the extension or delineation of the more obvious, and/or certain, fault traces. I have plotted the approximate locations of the various profiles Dr. Peterson ran and have also indicated those areas which could yield the greatest amount of information if additional studies are undertaken.

A plot of zones and mean pumice flattening ratios versus thickness estimated by Dr. Peterson is included as Figure 1. Profiles SHa, DC-14, EDa and SS apply to the Superior dacite. Some discrepancies in zone depths, may be eliminated if one assumes that Dr. Peterson's estimates of thickness were too high and that some of the lower zones may be subject to variance due to the different thicknesses of the overlying dacite. SHa was along Queen Creek and road cuts affording excellent exposures. By far, SHa is probably the most reliable curve. This is due to the good exposures, number of measurements taken and large horizontal extent.

I would suggest that a similar profile (IC, Iron Canyon, as shown on Attachment C be run from the base of the dacite west of Sutton's Summit, at least to the white unit on the west side of Devil's Canyon and preferably continuing towards Oak Flat until pumice fragments are indiscernable. This profile would have the long horizontal extent (therefor applicability) of SHa and also expose the complete range in dacite units to study. Measurements of pumice ratios from the brown unit up, for the area, could then be referred to this curve if it proved suitable. Exposures along the road cuts would make such a study fairly rapid with stations spaced approximately 1000 feet apart. There are about 20,000 feet from Signal Peak to Oak Flat; therefore, 20 stations. If, as appears to be the case, the dacite is faulted or is represented by a very thick section near Signal Peak, then closer spaced measurements or a "side" --north to south-- profile may have to be run. This could be offset by wider spacings of stations along Iron Canyon and part of Devil's Canyon in the gray unit.

Another excellent location for a profile is provided by drill

site, DC-1. There is drill hole data available as a check of dacite thickness as well as excellent exposures. Such a profile is traced as SDC-1 (South Devil's Canyon). A pumice measurement station should also include DC-1 drill hole site.

Another profile which might prove valuable although not as necessary as SDC-1 or IC might be run into Devil's Canyon (see proposed NDC profile, Attachment C) or from our drill road southwest of DCA-1 to the east (see alternate NDC profile).

Pumice ratio measurements should be made at every drill site for reference purposes. Poorly logged holes may be better interpreted using this data and known depths will strengthen ratio determinations in areas that have not been drilled. Pumice flattening ratios are a useful, (although complex) tool, for the determination of thicknesses for this welded-tuff flow and probably for others as well. This method is just as valid in application as are a wide variety of exploration aids. I would suggest that other exploration targets may well benefit from a continuation of our pumice ratio study and its implementation elsewhere where targets may be obscured by post-mineral ash-flows.

Dacite thickness may also be interpolated between drill holes and, in conjunction with ratio determinations, give good approximations of dacite depths.

A few sites are also proposed for future ratio determinations which will yield information relating directly to structure. (Attachment C)

I would estimate that a maximum of two, 5 day, weeks would be needed to run the three proposed profiles with five additional days required to complete measurements at the proposed stations

George S Barnett

George S. Barnett

GSB:sh

TAB

APPENDIX A

ZONED ASH–FLOW SHEET IN THE REGION AROUND SUPERIOR, ARIZONA[1]

By

Donald W. Peterson
U.S. Geological Survey, Menlo Park, California

INTRODUCTION

Remnants of a thick Tertiary ash-flow sheet cover large areas in parts of Gila, Pinal, and Maricopa Counties, Arizona (Fig. 1). The ash-flow sheet is of particular local interest because it covers potential mineral exploration targets in a region that has many ore deposits. This report briefly describes the physical features of the ash-flow sheet and explains how internal zoning can help interpret its structure.

Previous Work

The ash-flow sheet was first studied in the Globe 15-minute quadrangle by Ransome (1903, p. 88-95), who described the basal tuff correctly but considered the vitrophyre and the rest of the unit to be thick, massive lava flows of dacitic composition. Short and others (1943, p. 45-49) described the sheet near Superior as alternating dacitic lava flows and tuff deposits. N. P. Peterson carefully described the deposit in the vicinity of Globe and Miami (1962, p. 38-41). He realized that lava flows of this composition would be erupted as relatively short, viscous flows with contorted flow structures. This deposit, however, actually covers hundreds of square miles and contains uncontorted, flat to moderately tilted structures, so he concluded that it was probably laid down by several ash flows or incandescent clouds (N. P. Peterson, 1962, p. 40-41).

I have made additional studies of the deposit and have concluded that it is composed of a number of ash flows erupted in rapid enough succession to form an ash-flow sheet that is, in general, a simple cooling unit. The present report, outlining this thesis, is chiefly a condensation of an earlier open-file report (D. W. Peterson, 1961a).

Terminology

The terms used in this report follow the terminology proposed by Smith (1960a, p. 800-801). Abbreviated versions of several of Smith's definitions are repeated here.

Ash flow: The basic unit of ash-flow deposits; the deposit resulting from the passage of one nuée ardente.

Ash-flow sheet: Any unspecified sheetlike unit or group of units considered to be of ash-flow origin.

Welded tuff: A rock or rock body in which vitric particles have some degree of cohesion by reason of having been hot and viscous at the time of their emplacement.

Cooling unit: A single or multiple ash-flow deposit that can be shown to have undergone continuous cooling.

Simple cooling unit: An ash flow or sequence of ash flows that has had an essentially uninterrupted cooling history.

Compound cooling unit: One that shows departures in expectable zonation and other properties which result from simple cooling, because the intervals between ash flows were too great for readjustment to a single-unit cooling gradient.

To understand the definition of " ash flow" it may be helpful to review Smith's concept of "nuée ardente". He emphasized the original observation that a nuee ardente is composed of two parts, a basal avalanche that contains the bulk of the erupted material, and an overriding cloud of expanding gas and dust (Smith, 1960a, p. 802-804). Although a nuée ardente is both a type of eruption and an agent of transport, Smith emphasized its role as an agent of transport of material from the vent to its final resting place.

The deposit in the vicinity of Superior, Miami, and Globe is an "ash-flow sheet" made up of an undetermined number of separate "ash flows" that in most places cannot be individually recognized. Part of the deposit is composed of "welded tuff," and part is non-welded. In most places the ash-flow sheet constitutes a "simple cooling unit," but locally it grades laterally into a "compound cooling unit."

In most of the literature describing the area, "dacite" has been used to designate the rock type (Ransome, 1903, 1919, 1923; Short and others, 1943; Peterson and others, 1951; N.P. Peterson, 1962, 1963), and the name is firmly established in current local usage. Dacite is defined as a volcanic rock with

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1. Publication authorized by the Director, U.S. Geological Survey

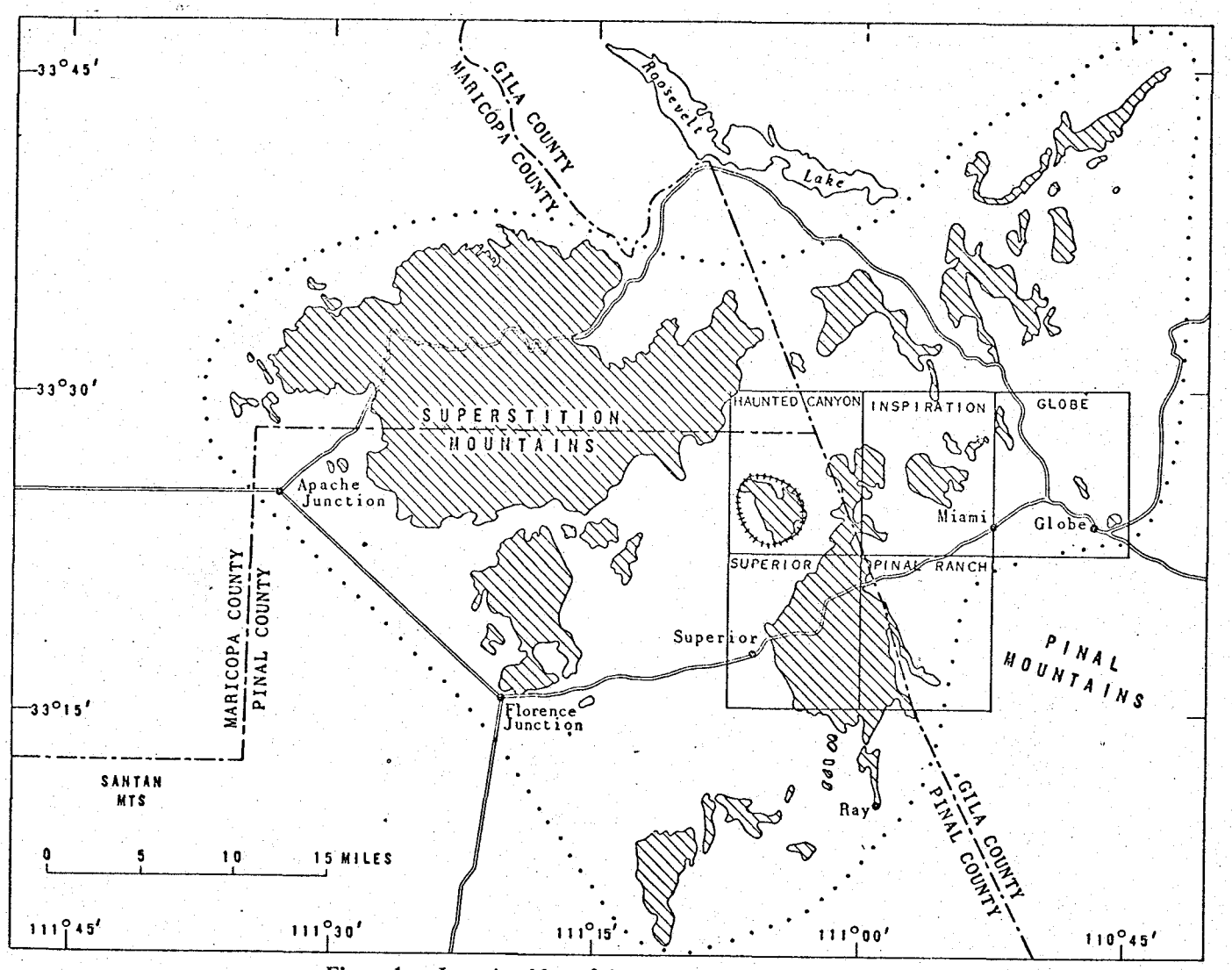

Figure 1 — Location Map of the Superior, Arizona Region

numerous quartz and feldspar phenocrysts, the feldspar phenocrysts being mostly plagioclase; on this basis dacite is a valid name for the rock. It should be recognized, however, that on the basis of its chemical composition, the rock is a quartz latite (Peterson, 1961a, p. 111).

ORIGINAL EXTENT, VOLUME, AND AGE

The area in which the ash-flow sheet crops out is shown in Figure 1. The deposit has been recognized from 10 miles west of the Superstition Mountains to the Salt River near Cherry Creek, and from a mile east of Globe to the vicinity of Ray. Outcrops of ash-flow rocks in the Santan Mountains may be part of the same sheet, but the correlation is not yet certain. The possible original extent of the sheet is indicated in Figure 1; this area is about 1500 square miles, but it may exceed 2000 square miles.

The maximum exposed thickness of the sheet is 2000 feet just east of Superior. Thicknesses of over 1000 feet are common in the central part of the area shown in Figure 1, and the sheet gradually thins toward its margin. The original thickness of the sheet is difficult to determine because of dissection by erosion and the irregular pre-eruption topography. However, 500 feet seems to be a reasonable estimate for the average thickness. This leads to an estimated volume for the sheet of about 150 cubic miles.

Ransome (1903, p. 94-95) assigned a Tertiary (?) age to the deposit, and this age is confirmed by isotope age dating techniques. Creasey and Kistler (1962, p. 1) determined an apparent absolute age of 20 million years on K-Ar ratios in biotite obtained from vitrophyre at the base of the deposit east of Superior. Damon and Bikerman (1964, p. 72) obtained an age of 19.9±0.9 million years on biotite from dacite about 2 miles east of Superior. (They

used a slightly different decay constant and recalculated the age obtained by Creasey and Kistler to 19.4 million years.) These dates all indicate a middle Miocene age.

FIELD DESCRIPTION

Zoning

All of the zones of welded ash flows defined and described by Smith (1960b) are present in this ash-flow sheet, and they are diagrammatically represented in Figure 2. The three fundamental zones that depend

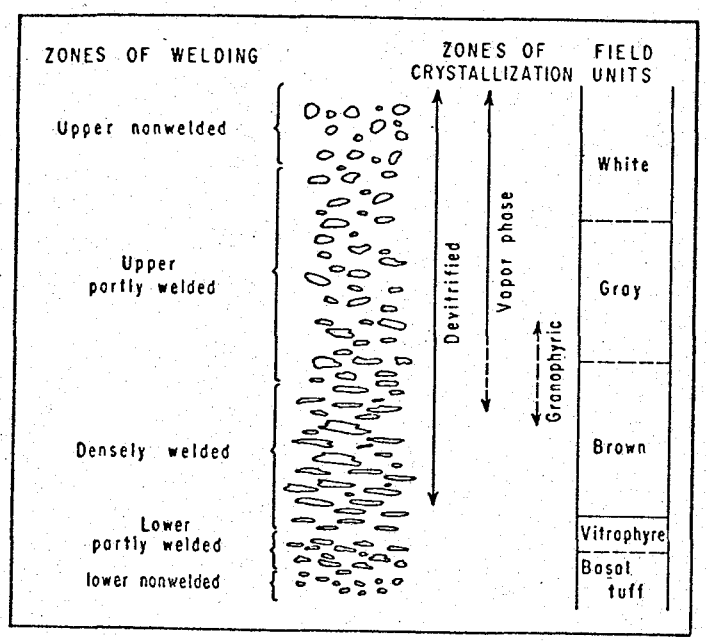

Figure 2 – Physical characteristics of the ash flow sheet

on the degree of welding include (1) upper and lower zones of no welding, (2) upper and lower zones of partial welding, and (3) the zone of dense welding. Superimposed on all but the lower part of the sheet are three zones representing the different types of crystallization that took place during the cooling of the sheet: (1) devitrification, (2) vapor-phase crystallization, and (3) granophyric crystallization. The zones of crystallization are superimposed upon the three fundamental zones of welding. In addition, the zones of crystallization overlap one another. In most vertical sections through the sheet, the successive zones in part follow the same pattern as indicated in Figure 2, without repetition or regression. This pattern indicates that, despite its great thickness, the sheet consists of a single cooling unit in most places.

The rocks of all the zones have certain features in common. Throughout the entire sheet the rocks are porphyritic with a similar phenocryst assemblage; in hand specimen phenocrysts can be identified as feldspar, quartz, biotite, accessory iron oxide, and lesser variable amounts of hornblende and sphene. Phenocrysts constitute from one-fourth to nearly one-half the volume of the rock; they range in size from barely discernible with the hand lens to 3 mm, and most are ½ to 1 mm in diameter.

Lithic inclusions are common throughout the ash-flow sheet, and generally make up 1 or 2 per cent of the rock. In the lower part of the sheet, however, they become much more abundant, generally making up about 10 per cent and locally as much as 25 per cent of the rock. All the older rocks of the district occur as inclusions. Most are angular chips a fraction of an inch in diameter, some are several inches across, and a few scattered boulders several feet in diameter have been observed.

In the field it has been convenient to map the following five units rather than the zones of crystallization or welding: (1) basal tuff, (2) vitrophyre, (3) brown unit, (4) gray unit, and (5) white unit. Some of these units have been mapped in part of the Superior quadrangle; Figure 3 shows their generalized distribution.

(1) The basal tuff includes the lower zone of no welding and part of the lower zone of partial welding. The glass shows no appreciable crystallization. The base of the ash-flow sheet consists of nonwelded crystal tuff wherever observed. The basal tuff is poorly to moderately indurated and weathers to gentle, subdued slopes. It is generally light gray to white but locally grades to shades of yellowish gray and moderate red. The basal tuff ranges in thickness from 2 to 100 feet or more, averaging about 10 to 20 feet.

The matrix of the nonwelded tuff is powdery and generally uniform; in addition to phenocrysts and lithic inclusions, it locally contains pumice lapilli and blocks. In the nonwelded tuff, orientation of constituents is random. Upward into the zone of partial welding, however, the pumice fragments and glass shards become flattened and uniformly oriented; as the tuff becomes more firmly consolidated, its specific gravity increases, and discs of black glass appear and become progressively more abundant upward. These changes all result from a progressive upward increase in the degree of welding. The zone of partial welding (the upper part of the basal tuff) ranges in thickness from a few inches to about 40 feet, averaging from 1 to 6 feet.

(2) The vitrophyre includes the lower part of the zone of dense welding that lacks superimposed crystallization. The lower part of the vitrophyre may also include the upper part of the lower zone of partial welding (Fig. 2). Most of the vitrophyre is a densely welded tuff composed of a matrix of black glass containing the normal assemblage of phenocrysts and sparse to abundant lithic inclusions. It is generally

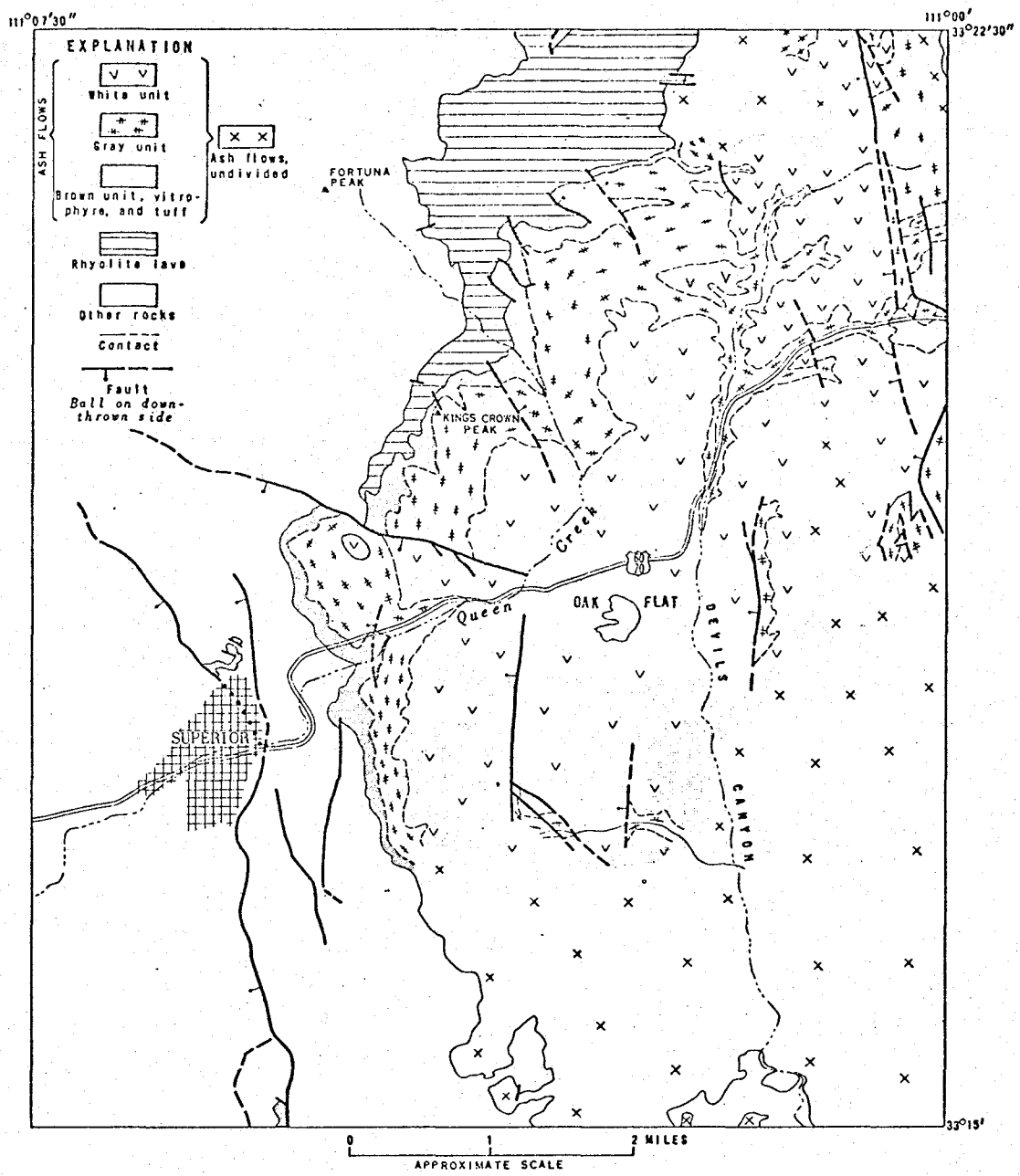

Figure 3 – Generalized geologic map of the Superior quadrangle, showing the distribution of recognized field units within the ash flow sheet. Recognition of the units has permitted identification of several faults within the sheet.

firm and resistant to weathering and stands out as a ledge above the softer basal tuff. The vitrophyre weathers to a dark gray or dark brown color that contrasts with the lighter colors of overlying and underlying rocks. It ranges in thickness from 2 to 80 feet and averages from 5 to 25 feet.

(3) The brown unit consists of the part of the zone of dense welding upon which has been superimposed the zone of devitrification. It also may include the lower part of the upper zone of partial welding, in which thin scattered lenticles that underwent vapor-phase crystallization are present. The dominant characteristic of the brown unit is a devitrification of the original glass of the groundmass to a dense, hard, flinty rock that is light brown to reddish brown in color. Careful scrutiny of the groundmass with a hand lens reveals eutaxitic structures characteristic of densely welded tuff; these structures show clearly under the microscope. The intensity of devitrification crystallization increases upward. This is expressed megascopically by a gradual change in color from brown to brownish gray to reddish gray. The thin,

light-colored lenticles in the upper part of the brown unit are flattened pumice fragments that have retained enough porosity to allow slight vapor phase crystallization; they gradually become more abundant upward into the upper zone of partial welding. The thickness of the brown unit cannot be given precisely, because of its gradational upper boundary, but it generally ranges from 20 to 200 feet. In Queen Creek Canyon the brown unit reaches its maximum thickness of about 450 feet.

(4) The gray unit lies entirely within the upper zone of partial welding, upon which the zone of devitrification crystallization has been strongly superimposed. This crystallization reaches the maximum coarseness in the gray unit, and in many places the original "welded-tuff texture" is obscured by the superimposed crystallization. The color of the rock ranges from reddish gray to medium and light gray. Pumice fragments are strongly flattened in the lower part of the unit and partly flattened in the upper part; as their flattening decreases, the amount of vapor-phase crystallization increases. However, welding of the groundmass throughout the gray unit was strong enough to confine vapor-phase crystallization chiefly to the pumice fragments. Both the lower and upper contacts of the gray unit are gradational. The unit ranges from a few feet to over a thousand feet in thickness.

(5) The white unit includes the upper part of the upper zone of partial welding and the entire upper zone of no welding. Its main characteristic is that vapor-phase crystallization not only occupies the pumice fragments but also permeates the groundmass and is there superimposed upon the devitrification crystallization. Crystallization is so intense that generally the original vitroclastic textures have been completely obliterated. The rock has an aphanitic groundmass that generally lacks planar or oriented structures. The color on the fresh surface is light gray to white; it weathers brownish gray to reddish gray, nearly the same as the gray unit. Pumice fragments range from partly flattened to nearly equidimensional in shape. On unweathered surfaces they are difficult to distinguish from the enclosing rock, but as the rock weathers to a darker color, the pumice fragments become more discernible. In most places erosion has removed a substantial part of the white unit, and only in the vicinity of Oak Flat, 4 miles east of Superior, has the original upper surface of the unit been recognized. The white unit has a maximum thickness of about 800 feet and averages perhaps 200 to 300 feet, but thicknesses are uncertain because of the gradational lower contact and the eroded upper surface.

Granophyric Crystallization

Smith (1960b, p. 152) defines granophyric crystallization as follows:

> "In silicic welded tuffs granophyric crystallization is characterized by groundmass quartz intergrown with, or as blebs associated with, alkalic feldspar and minor accessory minerals. The aggregate shows granophyric or micrographic textures similar to those shown by many slowly cooled rhyolitic flows, domes, and shallow intrusive rocks."

Granophyric textures are identified in thin section in specimens from the central part of the very thick section east of Superior. These textures occur chiefly in the centers of flattened pumice fragments in the lower part of the gray unit. The granophyric crystallization evidently took place where cooling was slowest and was promoted by the presence of residual vapors in the pumice fragments. The position of the granophyric crystallization zone illustrates well how the various zones of crystallization are superimposed on one another. This zone is thin, poorly defined, and discontinuous, and it is superimposed upon the zone of devitrification at a horizon where the zone of vapor-phase crystallization is also present.

Pumice Fragments

Light-colored cognate inclusions that are locally abundant in some parts of the ash-flow sheet have been identified as pumice fragments. They are lenticular to ovoid in shape; toward the top they are equidimensional, but downward they become progressively more flattened. Most of the inclusions range from 1 to 4 inches in their longest dimension, but both larger and smaller sizes are common. In general their light color contrasts with the slightly darker enclosing rock. Most of them carry approximately the same assemblage of phenocrysts in about the same proportions as the matrix and, except for their lighter color, appear to be practically the same rock. An important difference is that many of the phenocrysts in the enclosing rock are broken, whereas they are generally unbroken in the pumice fragments. The original pumiceous texture of the fragments has been largely obscured or obliterated by devitrification and vapor-phase crystallization, so that the fragments are now essentially a porphyritic rock with a uniform aphanitic groundmass.

The flattening of pumice fragments has been given considerable study (Peterson, 1961b). The apparent flatness of a fragment is defined as the ratio of its length to its height—a ratio which has a rather wide range of values at any given outcrop. The flattening ratio is defined as the mean value of the apparent

flatnesses of a representative number (generally 30 or 40) of fragments. This ratio can be calculated either as an arithmetical average or as the mean of the logarithms of the apparent flatnesses. These two methods yield slightly different values; the logarithmic flattening ratio is more rigorous, but the arithmetical flattening ratio is easier to calculate in the field. Figure 4

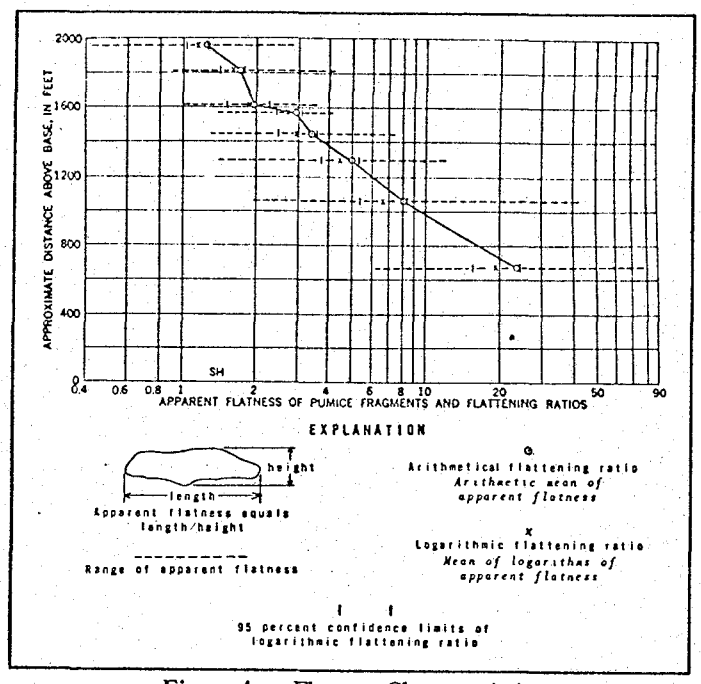

Figure 4 — Flatness Characteristics

shows the relation of the flattening ratio to the stratigraphic position in the ash-flow sheet; the flattening ratio increases as the depth of burial increases. This curve was obtained from fragments in the section of rocks exposed in roadcuts along U.S. Highway 60-70 between Superior and Oak Flat. Curves from other localities show similar relations.

Studies of flattening ratios have made it possible to estimate the amount of throw on faults in the ash-flow sheet. The flattening ratio also is a tool for estimating the distance of an outcrop below the original top of the sheet. Such applications are somewhat limited, however, because outcrops suitable for measurement of fragments are not numerous.

STRUCTURE OF THE ASH-FLOW SHEET

The term "sheet" appropriately describes the gross structure of the ash flows, inasmuch as the horizontal dimensions are many times greater than the thickness and the deposit extends over a wide area. The sheet was deposited on a surface of moderate to locally steep relief.

The attitude of most layering ranges from horizontal to dips of about 30°, but in a few places the dips are as much as 60°. The planar structure on which attitudes are measured is generally a joint system, distinct to indistinct, that lies parallel to the plane of flattening of the pumice fragments. It seems likely that the structures originally were nearly horizontal, and that the higher dips are due to post-solidification tilting. If the still-plastic rock had been deposited with an appreciable angle of dip, the rock would probably have flowed laterally, yet no evidence for such flowage has been recognized.

In earlier maps and reports, few faults were noted within the ash flows because of the uniform appearance of weathered surfaces from near the base to the top of the sheet. However, the distinct changes in lithology due to zoning and the systematic changes in the flattening ratio of pumice fragments provide the criteria that permit faults within the sheet to be recognized and mapped. A fresh surface must be obtained to identify the zone, so the work is rather slow and tedious; therefore, zones have been mapped and faults studied in detail in only a part of the Superior quadrangle (Fig. 3).

Several faults cutting the ash-flow sheet have been recognized, most of which probably belong to a single set. Most of the faults trend north to northwest, and the west or southwest side is dropped down, although a few have the opposite sense of displacement. Hammer and Peterson (in press) describe two principal sets of faults that cut the rocks of the Superior area. The older set trends principally eastward, and many of the faults are mineralized. Most of these faults are pre-Tertiary in age. The younger set trends north to northwest; its faults displace faults of the older set and offset Tertiary as well as older rocks. In general these faults are not mineralized. Most of the faults illustrated in Figure 3 belong to this second set.

Nearly everywhere the ash-flow sheet is cut by a system of vertical or nearly-vertical joints. The joints vary from clearly defined to indistinct, and from widely to closely spaced; most are from 5 to 15 feet apart. The joints commonly form distinct systems, in which parallel joints extend continuously for several hundred feet to more than a mile. In many places two joint systems intersect each other at angles from 60° to 90°. The continuity of the joints suggests that they are of tectonic origin, and are not simple cooling cracks. However, polygonal cooling joints are found in a few places, mostly in the vitrophyre.

SOURCE

The major source or sources of the ash flows have not yet been identified. Further study in areas west of the Haunted Canyon and Superior quadrangles may ultimately reveal the major eruptive center. However, a small caldera, about 3 miles in diameter, has been recognized in the southwestern part of the Haunted

Canyon quadrangle (Peterson, 1961a); its position is outlined in Figure 1. This caldera was probably the source for part of the deposit. At most, however, it could have supplied about 10 cubic miles of material –only a fraction of the total volume of the sheet (Peterson, 1961a, p. 71-72).

The caldera is a crudely circular structure in which ash flows and underlying rhyolite are downdropped and are surrounded by rocks of Paleozoic and Precambrian age (Peterson, 1960). The relations between the volcanic rocks and the older rocks around the border of the structure are complex and chaotic, and the older rocks are locally intruded by dikes of vitroclastic material similar to that in the ash-flow sheet. Local zones of alteration are common in the ash flows and rhyolite within the caldera. Erosion has removed all traces of any original topographic expression of a collapse feature, but the foregoing evidence is considered sufficient to identify the caldera (Peterson, 1961a, p. 66-72). Similar structures, perhaps larger, may lie farther west. M. F. Sheridan has tentatively recognized caldera-like structures in the western part of the Superstition Mountains (oral communication, 1967), which may provide additional sources for the ash flows.

PETROGRAPHY AND MINERALOGY

The nature, distribution, and appearance of phenocrysts throughout most of the ash-flow sheet are remarkably constant. They are nearly uniformly distributed, and constitute from 35 to 45 per cent of the rock. Plagioclase is the most abundant phenocryst mineral, followed by lesser amounts of quartz, biotite, sanidine, and opaque oxides. Hornblende is present in some specimens and absent in others. Sphene, apatite, and zircon are common accessory minerals, and a few specimens contain a little tourmaline. Over a hundred modal analyses show that the relative proportions of the different phenocryst minerals show a slight but systematic change from the bottom to the top of the sheet. Plagioclase decreases slightly, and quartz and sanidine increase.

The major phenocrysts average between ½ and 1 mm in diameter, but a few are as large as 3 mm. Except for the phenocrysts in pumice fragments, a high proportion of phenocrysts throughout the sheet are broken, and tiny angular crystal fragments are scattered through the matrix.

The plagioclase crystals, constituting from 55 to 80 per cent of all phenocrysts, are generally subhedral, rarely anhedral, and are commonly twinned after one or more twin laws. Most are distinctly zoned, showing either normal or oscillatory-normal patterns. Optical and X-ray diffraction studies of the plagioclase have not shown a unique composition, but they indicate that it lies in the range from oligoclase to andesine and probably has an intermediate structural state.

The ash-flow sheet generally contains only a small number of sanidine phenocrysts, about 1/2 to 5 per cent of the phenocrysts. In the white unit, however, sanidine makes up from 6 to 15 per cent of the phenocrysts. In all units the sanidine is subhedral or euhedral, and some crystals show slight to moderate corrosion and embayment of their borders. Most are untwinned, but a few are twinned on the Carlsbad law. X-ray diffraction study indicates an approximate composition of Or_{85}-Ab_{15}.

Quartz phenocrysts are anhedral and approximately equant, and they generally have deeply embayed borders. Quartz constitutes from 5 to 14 per cent of the phenocrysts in most of the ash-flow sheet, but from 11 to 25 per cent in the white unit. Grains are clear and unaltered, and some contain liquid inclusions. The quartz in most specimens shows slightly undulatory extinction.

In all parts of the sheet biotite makes up from 5 to 13 per cent of the phenocrysts and averages about 8 per cent. Biotite phenocrysts are generally euhedral or subhedral and form tabular books and flakes; many grains are distorted and bent. "Bird's-eye" structure is common, and pleochroism is pronounced with X = yellow, Y = Z = dark brown. Biotite in the lower part of the sheet is fresh, but in the upper part of the brown unit it is slightly altered, and farther upward the alteration becomes progressively more intense. Alteration begins as bleaching at the crystal boundaries and development of small clots of opaque oxides in the bleached areas. The bleaching progresses inward with further alteration, particularly along cleavage planes, and the opaque clots enlarge. Alteration is most intense in the white unit, where biotite is either replaced by chlorite or is completely bleached and accompanied by large concentrations of opaque oxide clots.

HISTORY OF THE ASH-FLOW SHEET

The magma, with a chemical composition of quartz latite, probably originated by selective melting of sialic material at a depth of several kilometers (Peterson, 1961a, p. 113-115). As it migrated upward it cooled, and plagioclase, sanidine, quartz, biotite, and other minerals crystallized. As crystallization continued, gas pressure rose; when about 40 per cent of the magma had crystallized, it found its way explosively to the surface. The properties of the magma–such as temperature, viscosity, and gas content–were such that it erupted as nuées ardentes. Gas escaped with enough violence to disrupt the magma into ash-sized particles, and the explosively vesiculating magma rapidly spread laterally in all directions as a gas-charged avalanche.

Mobility was aided by air engulfed by the incandescent mass; the suddenly heated air expanded violently, speeding the avalanche forward along its path and creating a constant turbulence within it (McTaggart, 1960). Billowing clouds of dust undoubtedly rose to great heights, but the bulk of the material was carried by the basal avalanche.

Successive eruptions rapidly followed one another; each eruption was an individual pulse separated from the next pulse by hours or days, but each successive layer was added before the next underlying layer had cooled appreciably. Each eruptive pulse added from a few tens to several hundred feet of material to the deposit. The erupted material had sufficient energy and mobility to travel distances of as much as 20 miles. The original relief was moderate to steep, perhaps on the order of 1000 feet; the deposits filled in valleys and ultimately covered hills under depths of several hundred feet.

The first material that came to rest on the cool prevolcanic surface was quickly chilled, and the glass particles became rigid enough to resist deformation. This material (the lower nonwelded zone) formed an insulating blanket causing material above it to cool more slowly, so that shards and pumice fragments retained their plasticity long enough to be deformed and flattened by the weight of the overlying material, thereby giving rise to the lower partly welded zone. The vitrophyre represents a layer in which the particles were plastic enough to become greatly flattened and thoroughly welded together, yet were chilled quickly enough to form a glass.

In a thick layer above the vitrophyre the still-plastic particles were deformed by the overlying load and thoroughly welded. Cooling, however, was slower, and the originally glassy constituents devitrified to form the cryptocrystalline, aphanitic groundmass characteristic of the brown unit. Higher in the sheet the overlying load was smaller and the degree of welding gradually decreased, so that some porosity was retained. Escaping gases collected in these pore spaces to promote additional crystallization. The intensity of vapor-phase crystallization increased upward as the degree of welding decreased and became still more intense through the gray unit. Finally the upward-streaming gases permeated all the spaces between particles to cause vapor-phase crystallization through the entire white unit. As crystallization became more complete, the outlines of particles became more diffuse because crystals grew across shard boundaries. Near the top of the sheet the particles were essentially undeformed and nonwelded, but their original outlines were ultimately obliterated by crystallization, owing to long contact with upward-rising hot gases.

The region was either standing high or was uplifted soon after the ash-flow eruptions, for erosion deeply dissected the sheet and locally cut entirely through it. Fluvial deposition followed, and the Gila Conglomerate was deposited in local basins. In some areas air-fall tuffs and lava flows, ranging in composition from basalt to rhyolite, were erupted and locally interfinger with the Gila Conglomerate. Abundant faults cut both the ash-flow sheet and the younger rocks.

Renewed uplift halted deposition of the Gila, erosion continued to dissect the ash-flow sheet and to cut into the younger rocks, and gradually the present-day topography developed.

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TAB

APPENDIX B

ASARCO DACITE DATA

Individual(s) Readings - Ratios
Uncorrected Data

George S. Barnett April 20, 1971

TATION SHAFT SH1 DATE 11-12-70 RECORDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
14.25	2.20	6.477	2.20	0.50	4.400	6.20	1.00	6.200
5.50	1.70	3.235	1.10	0.20	5.500	3.40	0.50	6.800
5.90	0.50	11.800	5.80	1.10	5.272	3.70	0.50	7.400
10.00	0.80	12.500	10.80	1.80	6.000	6.20	3.20	1.937
6.00	0.85	7.058	15.80	2.40	6.583	3.90	0.60	6.500
5.70	1.50	3.800	6.40	1.70	3.764	3.00	1.60	1.875
5.00	1.10	4.545	3.30	1.50	2.200	8.40	1.50	5.600
7.20	2.00	3.600	11.35	3.70	3.067	7.30	2.00	3.650
11.70	3.80	3.078	15.40	2.60	5.923	8.30	1.40	5.928
12.10	1.90	6.368	5.80	2.30	2.521	4.00	0.50	8.000
0.00	0.00	0.000	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 5.386
LOG AVE OF RATIOS = 0.68534
STANDARD DEVIATION = 1.813
95 PERCENT INTERVAL = 5.386 +/- 0.64

ASARCO DACITE DATA SH-1 SAMPLES TAKEN 11/12/70 BY RAMON SHANNON

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
1.50	0.50	3.000	3.20	0.70	4.571	1.90	0.40	4.750
2.60	0.70	3.714	4.50	0.80	5.625	6.00	1.00	6.000
2.60	0.40	6.500	2.40	0.40	6.000	1.50	0.50	3.000
4.50	1.70	2.647	2.20	0.40	5.500	2.80	1.00	2.800
1.40	0.40	3.500	1.80	0.40	4.500	0.00	0.00	0.000
0.00	0.00	0.000	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 4.436
LOG AVE OF RATIOS = 0.62769
STANDARD DEVIATION = 1.598
95 PERCENT INTERVAL = 4.436 +/- 0.83

STATION SHAFT SH2 DATE 11-12-70 RECORDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
3.50	0.80	4.375	3.30	1.20	2.750	9.00	1.50	6.000
9.50	2.60	3.653	4.20	1.10	3.818	5.30	1.60	3.312
3.40	1.20	2.833	10.50	3.10	3.387	5.00	0.70	7.142
4.00	1.00	4.000	9.00	1.10	8.181	2.70	1.10	2.454
4.70	1.20	3.916	1.70	0.70	2.428	7.20	1.40	5.142
2.80	1.10	2.545	3.50	0.85	4.117	6.00	2.20	2.727
6.20	1.10	5.636	4.60	1.90	2.421	2.70	0.35	7.714
3.50	0.80	4.375	4.40	1.20	3.666	2.50	0.45	5.555
3.20	1.00	3.200	3.40	0.70	4.857	2.50	0.35	7.142
6.10	1.50	4.066	6.20	0.70	8.857	3.20	1.10	2.909
0.00	0.00	0.000	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 4.439
LOG AVE OF RATIOS = 0.61491
STANDARD DEVIATION = 1.550
95 PERCENT INTERVAL = 4.439 +/- 0.55

STATION SHAFT SH2 DATE 11-12-70 RECORDER RAMON SHANNON

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
2.50	0.40	6.250	2.50	0.40	6.250	4.00	0.50	8.000
3.30	0.80	4.125	5.00	0.80	6.250	3.40	1.10	3.090
5.60	2.00	2.800	3.20	0.90	3.555	4.00	1.70	2.352
2.90	0.60	4.833	2.50	0.70	3.571	3.10	0.50	6.200
4.80	1.50	3.200	3.40	0.40	8.500	43.50	0.70	62.142
43.10	0.80	53.875	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 11.562
LOG AVE OF RATIOS = 0.79716
STANDARD DEVIATION = 2.997
95 PERCENT INTERVAL = 11.562 +/- 1.46

STATION SHAFT SH3 DATES 11-12-70 RECORDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
9.70	1.30	7.461	*****	1.40	71.928	60.80	1.50	40.533
40.00	0.60	66.666	90.50	1.50	60.333	90.20	0.95	94.947
3.00	0.60	5.000	5.50	1.20	4.583	4.20	0.25	16.800
5.40	1.70	3.176	5.10	1.15	4.434	8.50	0.95	8.947
3.20	1.10	2.909	7.10	1.20	5.916	3.00	0.80	3.750
3.00	1.00	3.000	5.50	0.50	11.000	4.10	1.00	4.100
12.15	3.10	3.919	4.30	0.50	8.600	15.00	2.70	5.555
2.80	4.50	0.622	4.90	1.00	4.900	3.40	1.10	3.090
2.50	0.40	6.250	4.70	1.65	2.848	7.60	1.80	4.222
5.50	0.60	9.166	2.40	0.90	2.666	0.00	0.00	0.000
0.00	0.00	0.000	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 16.114
LOG AVE OF RATIOS = 0.86404
STANDARD DEVIATION = 3.659
95 PERCENT INTERVAL = 16.114 +/- 1.33

STATION SHAFT SH 3 DATE 11-12-70 RECORDER RAMON SHANNON

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
3.70	0.70	5.285	2.30	0.60	3.833	4.70	0.40	11.750
1.80	0.70	2.571	3.30	0.80	4.125	1.70	0.60	2.833
3.00	0.60	5.000	2.30	0.40	5.750	2.70	0.70	3.857
3.30	0.40	8.250	3.00	0.70	4.285	4.20	0.80	5.250
3.40	0.70	4.857	2.90	0.60	4.833	3.30	0.70	4.714
2.70	0.60	4.500	1.40	0.20	7.000	2.70	0.60	4.500
1.20	0.30	4.000	2.00	0.40	5.000	3.70	1.30	2.846
2.10	0.30	7.000	1.50	0.60	2.500	4.00	0.60	6.666
2.60	0.60	4.333	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 5.021
LOG AVE OF RATIOS = 0.67290
STANDARD DEVIATION = 1.738
95 PERCENT INTERVAL = 5.021 +/- 0.68

STATION SUTTON'S SUMMIT SS 1 DATE 11-24-70 RECORDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
6.60	1.20	5.500	13.60	1.75	7.771	2.50	0.80	3.125
7.50	2.20	3.409	6.00	1.70	3.529	2.20	0.60	3.666
2.10	0.70	3.000	1.40	0.40	3.500	3.40	0.60	5.666
4.00	0.70	5.714	35.00	6.60	5.303	21.10	4.30	4.906
16.70	3.70	4.513	7.80	2.10	3.714	3.50	0.80	4.375
6.10	1.00	6.100	2.90	2.90	1.000	3.20	3.40	0.941
9.00	5.20	1.730	3.40	3.25	1.046	3.40	1.40	2.428
2.20	0.70	3.142	3.60	1.40	2.571	3.40	1.30	2.615
2.40	1.30	1.846	1.70	0.40	4.250	5.00	2.80	1.785
2.70	0.30	9.000	5.90	1.90	3.105	2.10	1.70	1.235
0.00	0.00	0.000	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 3.683
LOG AVE OF RATIOS = 0.49980
STANDARD DEVIATION = 1.256
95 PERCENT INTERVAL = 3.683 +/- 0.44

STATION-SUTTON'S SUMMIT (SS) 2 DATE 11-24-70 RECORDER RAMON SHANNON

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
8.50	3.40	2.500	4.00	1.10	3.636	4.80	1.40	3.428
6.00	1.10	5.454	2.20	0.90	2.444	2.60	0.80	3.250
3.50	1.30	2.692	5.00	1.80	2.777	3.70	1.00	3.700
6.00	1.90	3.157	11.50	4.00	2.875	6.60	2.20	3.000
4.90	1.10	4.454	1.80	0.50	3.600	3.40	0.60	5.666
7.00	1.50	4.666	6.00	1.00	6.000	2.10	0.60	3.500
8.00	2.00	4.000	4.70	0.80	5.875	3.50	0.40	8.750
13.50	2.40	5.625	9.50	2.00	4.750	5.00	1.00	5.000
2.50	0.50	5.000	7.40	1.20	6.166	7.30	1.60	4.562
5.50	1.20	4.583	7.50	1.50	5.000	6.30	2.00	3.150
0.00	0.00	0.000	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 4.308
LOG AVE OF RATIOS = 0.61342
STANDARD DEVIATION = 1.525
95 PERCENT INTERVAL = 4.308 +/- 0.54

STATION SUTTON'S SUMMIT SS 2 DATE 11-24-70 RECORDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
5.80	1.60	3.625	3.50	1.70	2.058	14.50	2.40	6.041
10.70	1.20	8.916	8.40	0.25	33.600	5.10	1.40	3.642
7.80	2.20	3.545	3.80	1.00	3.800	12.00	3.40	3.529
4.50	1.80	2.500	6.30	1.40	4.500	3.80	0.25	15.200
2.80	0.20	14.000	4.00	0.80	5.000	3.50	0.55	6.363
2.50	0.30	8.333	4.70	0.55	8.545	9.40	1.75	5.371
7.80	1.40	5.571	2.15	0.50	4.300	5.00	1.10	4.545
7.20	1.00	7.200	3.50	0.23	15.217	5.00	0.55	9.090
6.80	1.10	6.181	2.25	0.50	4.500	4.20	0.55	7.636
2.40	0.50	4.800	1.80	0.45	4.000	8.00	2.30	3.478
0.00	0.00	0.000	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 7.169
LOG AVE OF RATIOS = 0.76735
STANDARD DEVIATION = 2.239
95 PERCENT INTERVAL = 7.169 +/- 0.80

STATION-SUTTON'S SUMMIT (SS) 3 DATE 11-24-70 RECORDER RAMON SHANNON

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
14.00	3.00	4.666	8.50	2.00	4.250	3.80	1.40	2.714
9.00	2.50	3.600	4.90	1.00	4.900	5.20	0.70	7.428
1.20	0.50	2.400	8.00	2.50	3.200	3.40	1.20	2.833
7.80	1.80	4.333	8.00	1.50	5.333	3.70	0.80	4.625
12.00	1.60	7.500	4.70	0.60	7.833	6.00	0.70	8.571
6.50	0.60	10.833	5.10	3.00	1.700	8.00	1.00	8.000
5.40	2.00	2.700	5.50	2.00	2.750	3.00	0.80	3.750
7.70	1.50	5.133	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 4.957
LOG AVE OF RATIOS = 0.64729
STANDARD DEVIATION = 1.696
95 PERCENT INTERVAL = 4.957 +/- 0.70

STATION JI RANCH JI 1 DATE 11-24-70 RECORDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
9.00	1.20	7.500	5.00	2.80	1.785	3.00	1.05	2.857
4.30	1.00	4.300	2.00	0.70	2.857	13.00	4.20	3.095
6.10	3.00	2.033	2.50	1.30	1.923	9.10	3.60	2.527
11.85	5.30	2.235	5.60	4.50	1.244	3.30	3.00	1.100
3.70	2.90	1.275	6.55	1.80	3.638	9.10	1.10	8.272
11.30	3.80	2.973	3.50	0.80	4.375	7.70	2.40	3.208
3.90	1.00	3.900	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 3.216
LOG AVE OF RATIOS = 0.44419
STANDARD DEVIATION = 1.114
95 PERCENT INTERVAL = 3.216 +/- 0.50

STATION-JJ RANCH (JJ) 1 DATE 12-24-70 RECORDER-RAMON SHANNON

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
5.30	1.10	4.818	22.00	6.00	3.666	1.70	0.30	5.666
7.00	1.50	4.666	6.50	3.50	1.857	4.50	1.20	3.750
2.30	0.70	3.285	5.40	0.90	6.000	4.60	0.70	6.571
7.50	0.60	12.500	3.70	0.80	4.625	6.00	1.50	4.000
7.00	0.10	70.000	1.80	1.30	1.384	4.80	1.20	4.000
8.80	1.30	6.769	2.50	1.70	1.470	1.70	0.80	2.125
4.50	1.00	4.500	6.30	1.80	3.500	2.80	0.50	5.600
4.10	0.90	4.555	4.90	0.40	12.250	4.90	1.10	4.454
4.50	0.90	5.000	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 7.480
LOG AVE OF RATIOS = 0.67770
STANDARD DEVIATION = 2.165
95 PERCENT INTERVAL = 7.480 +/- 0.84

TATION JI RANCH JI 2 DATE 11-24-70 RECORDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
11.60	7.00	1.657	8.00	1.00	8.000	4.20	0.70	6.000
16.20	7.50	2.160	2.70	0.50	5.400	15.10	6.50	2.323
10.00	4.00	2.500	17.00	3.20	5.312	14.40	4.10	3.512
17.80	3.20	5.562	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 4.242
LOG AVE OF RATIOS = 0.57475
STANDARD DEVIATION = 1.512
95 PERCENT INTERVAL = 4.242 +/- 0.93

STATION-JJ RANCH (JI) 2 DATE 11-24-70 RECORDER-RAMON SHANNON

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
7.30	2.30	3.173	8.00	3.00	2.666	7.40	0.70	10.571
14.00	5.00	2.800	17.10	3.50	4.885	16.50	8.80	1.875
10.60	4.10	2.585	7.20	2.00	3.600	9.30	3.40	2.735
17.50	4.60	3.804	8.90	1.30	6.846	7.10	0.80	8.875
10.70	1.50	7.133	12.20	2.70	4.518	8.20	0.80	10.250
20.80	3.20	6.500	18.20	4.50	4.044	13.20	5.10	2.588
15.30	2.00	7.650	7.90	2.40	3.291	4.70	2.10	2.238
4.40	0.80	5.500	2.20	0.80	2.750	11.70	3.90	3.000
9.50	3.50	2.714	2.10	1.00	2.100	6.90	1.10	6.272
6.30	2.60	2.423	7.20	1.80	4.000	0.00	0.00	0.000
0.00	0.00	0.000	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 4.530
LOG AVE OF RATIOS = 0.60102
STANDARD DEVIATION = 1.548
95 PERCENT INTERVAL = 4.530 +/- 0.56

STATION OAK FLAT (OF) 1 DATE 11-25-70 REOCRDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
3.40	0.60	5.666	2.50	1.15	2.173	9.20	3.30	2.787
2.50	1.00	2.500	2.90	1.10	2.636	2.20	2.10	1.047
10.50	6.10	1.721	11.50	7.20	1.597	13.80	4.80	2.875
17.10	9.80	1.744	13.10	3.60	3.638	11.90	3.90	3.051
14.40	3.60	4.000	10.30	5.80	1.775	7.20	3.20	2.250
12.90	6.40	2.015	8.50	5.00	1.700	6.00	4.40	1.363
9.00	5.10	1.764	26.20	9.60	2.729	4.15	3.80	1.092
4.60	4.00	1.150	4.00	4.10	0.975	4.40	2.60	1.692
3.20	3.50	0.914	13.30	7.20	1.847	7.20	3.80	1.894
3.50	2.90	1.206	2.40	1.80	1.333	0.00	0.00	0.000
0.00	0.00	0.000	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 2.108
LOG AVE OF RATIOS = 0.28084
STANDARD DEVIATION = 0.703
95 PERCENT INTERVAL = 2.108 +/- 0.25

STATION OAK FLAT (OF) 2 DATE 11-25-70 RECORDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
6.80	2.20	3.090	6.80	2.20	3.090	1.90	0.75	2.533
3.50	1.10	3.181	3.50	1.00	3.500	1.50	0.80	1.875
2.60	1.45	1.793	6.20	25.00	0.248	3.90	23.00	0.169
6.70	25.00	0.268	3.00	29.00	0.103	5.60	2.90	1.931
1.70	2.30	0.739	4.30	1.50	2.866	2.30	1.10	2.090
8.35	2.80	2.982	4.30	4.00	1.075	4.00	1.25	3.200
3.70	0.90	4.111	8.00	4.50	1.777	4.30	2.30	1.869
2.50	1.10	2.272	3.50	1.70	2.058	7.10	2.10	3.380
6.50	3.30	1.969	9.50	2.80	3.392	4.70	1.70	2.764
4.50	3.60	1.250	5.80	2.60	2.230	0.00	0.00	0.000
0.00	0.00	0.000	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 2.131
LOG AVE OF RATIOS = 0.20737
STANDARD DEVIATION = 0.486
95 PERCENT INTERVAL = 2.131 +/- 0.17

STATION OAK FLAT (OF) 3 DATE 11-25-70 RECORDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
7.50	1.90	3.947	8.10	1.25	6.480	7.50	3.20	2.343
5.55	1.75	3.171	3.70	2.00	1.850	3.40	1.35	2.518
3.50	1.20	2.916	8.30	3.00	2.766	4.20	2.30	1.826
6.00	2.80	2.142	3.60	1.40	2.571	4.55	1.80	2.527
9.30	3.70	2.513	3.10	1.30	2.384	4.00	1.85	2.162
3.50	1.20	2.916	3.20	1.20	2.666	1.30	1.55	0.838
4.30	2.20	1.954	2.40	1.15	2.086	3.10	1.10	2.818
8.10	3.80	2.131	2.70	1.40	1.928	2.00	2.10	0.952
4.10	2.20	1.863	3.30	1.60	2.062	11.20	4.70	2.382
0.00	0.00	0.000	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 2.471
LOG AVE OF RATIOS = 0.36302
STANDARD DEVIATION = 0.876
95 PERCENT INTERVAL = 2.471 +/- 0.33

STATION THROW NO. (235) 1 DATE 11-25-70 RECORDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
12.20	7.60	1.605	11.20	4.60	2.434	6.00	26.00	0.230
12.90	7.40	1.743	5.20	1.50	3.466	3.10	0.70	4.428
14.40	5.50	2.618	8.40	4.70	1.787	6.10	1.50	4.066
1.90	0.80	2.375	6.80	2.90	2.344	10.60	3.80	2.789
2.90	2.10	1.380	8.70	3.50	2.485	8.60	2.70	3.185
2.50	2.20	1.136	4.30	1.90	2.263	4.50	0.90	5.000
6.80	2.50	2.720	3.30	0.90	3.666	7.70	2.60	2.961
10.70	6.10	1.754	8.90	5.70	1.561	9.90	4.00	2.475
4.70	2.00	2.350	3.50	2.10	1.666	7.60	3.00	2.533
0.00	0.00	0.000	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 2.482
LOG AVE OF RATIOS = 0.34442
STANDARD DEVIATION = 0.838
95 PERCENT INTERVAL = 2.482 +/- 0.31

STATION THROW NO. (235) 2 DATE 11-25-70 RECORDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
4.20	1.00	4.200	5.00	2.15	2.325	2.80	1.05	2.666
18.60	11.30	1.646	12.30	5.20	2.365	12.40	5.50	2.254
12.50	5.60	2.232	9.20	4.50	2.044	12.20	7.30	1.671
20.60	12.00	1.716	7.10	3.90	1.820	8.50	4.90	1.734
9.10	4.10	2.219	16.70	6.80	2.455	13.50	2.00	6.750
7.20	2.40	3.000	5.60	3.10	1.806	10.70	4.80	2.229
2.30	1.30	1.769	10.40	40.00	0.260	8.00	4.30	1.860
10.70	7.40	1.445	5.10	1.40	3.642	8.30	2.20	3.772
10.60	3.50	3.028	5.40	3.50	1.542	7.00	4.80	1.458
8.60	3.70	2.324	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 2.365
LOG AVE OF RATIOS = 0.32334
STANDARD DEVIATION = 0.793
95 PERCENT INTERVAL = 2.365 +/- 0.29

STATION CREEK (CRK) 0 DATE 12-03-70 RECORDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
9.80	3.30	2.969	5.80	1.30	4.461	5.00	2.45	2.040
5.60	0.70	8.000	4.60	2.15	2.139	8.20	1.50	5.466
4.60	2.60	1.769	4.90	1.60	3.062	8.00	3.80	2.105
8.50	3.20	2.656	5.90	1.00	5.900	6.30	1.10	5.727
6.50	1.45	4.482	6.40	*****	0.000	5.10	1.40	3.642
7.70	3.40	2.264	1.90	2.10	0.904	4.50	0.60	7.500
4.50	1.10	4.090	7.40	*****	0.000	21.30	5.50	3.872
11.70	6.30	1.857	9.70	2.90	3.344	5.20	1.90	2.736
5.00	1.20	4.166	4.30	1.50	2.866	4.30	1.80	2.388
5.70	1.50	3.800	2.90	1.05	2.761	2.00	0.75	2.666
7.70	3.40	2.264	4.80	1.00	4.800	6.80	2.80	2.428
6.50	1.70	3.823	3.50	1.90	1.842	6.30	2.10	3.000
7.80	3.90	2.000	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 3.238
LOG AVE OF RATIOS = 0.14785
STANDARD DEVIATION = 1.299
95 PERCENT INTERVAL = 3.238 +/- 0.41

STATION CREEK (CRK) 1 DATE 12-03-70 RECORDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
8.00	1.90	4.210	2.60	0.70	3.714	4.30	1.40	3.071
7.90	1.80	4.388	4.20	4.60	0.913	4.20	2.70	1.555
6.00	2.90	2.068	5.00	1.25	4.000	3.00	3.00	1.000
3.20	2.40	1.333	10.00	3.60	2.777	6.00	1.30	4.615
1.80	1.30	1.384	2.10	1.15	1.826	4.70	4.30	1.093
2.30	1.25	1.840	5.50	5.20	1.057	28.90	7.30	3.958
2.10	1.60	1.312	3.50	0.45	7.777	2.90	2.30	1.260
2.20	0.90	2.444	5.40	1.60	3.375	10.20	4.10	2.487
8.20	1.60	5.125	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 2.743
LOG AVE OF RATIOS = 0.36346
STANDARD DEVIATION = 0.912
95 PERCENT INTERVAL = 2.743 +/- 0.35

STATION CREEK (CRK) 1 DATE 12-04-70 RECORDER RAMON SHANNON

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
7.90	1.10	7.181	9.00	3.90	2.307	2.50	1.80	1.388
4.70	3.50	1.342	4.70	1.30	3.615	5.00	1.00	5.000
7.00	2.00	3.500	3.60	1.20	3.000	3.60	1.30	2.769
10.00	1.40	7.142	3.60	1.30	2.769	3.50	0.80	4.375
3.60	0.80	4.500	8.50	2.50	3.400	3.00	1.20	2.500
5.30	1.10	4.818	3.30	1.50	2.200	11.50	2.20	5.227
13.00	1.30	10.000	6.50	0.90	7.222	7.00	1.00	7.000
6.30	0.90	7.000	10.60	0.80	13.250	6.10	0.70	8.714
10.40	1.00	10.400	6.60	0.70	9.428	8.70	2.30	3.782
10.00	2.00	5.000	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 5.315
LOG AVE OF RATIOS = 0.65548
STANDARD DEVIATION = 1.760
95 PERCENT INTERVAL = 5.315 +/- 0.65

STATION CREEK (CRK) 2A DATE 12-03-70 RECORDER GEORGE BARNETT(N75W)

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
12.20	2.05	5.951	5.90	1.80	3.277	8.10	1.20	6.750
3.40	1.90	1.789	8.20	1.70	4.823	20.00	4.60	4.347
2.40	0.80	3.000	2.20	0.60	3.666	5.00	1.35	3.703
14.20	3.05	4.655	2.60	1.20	2.166	3.60	0.60	6.000
3.65	1.10	3.318	6.60	0.80	8.250	3.60	1.00	3.600
2.50	0.65	3.846	3.55	1.40	2.535	5.20	1.20	4.333
3.20	0.85	3.764	5.30	1.30	4.076	3.45	0.50	6.900
5.90	1.10	5.363	7.40	1.30	5.692	5.70	1.45	3.931
7.40	1.35	5.481	3.30	0.90	3.666	3.90	1.00	3.900
6.20	2.05	3.024	5.60	1.40	4.000	4.20	0.80	5.250
0.00	0.00	0.000	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 4.368
LOG AVE OF RATIOS = 0.61688
STANDARD DEVIATION = 1.540
95 PERCENT INTERVAL = 4.368 +/- 0.55

2A

STATION CREEK (CRK) DATE 12-03-70 RECORDER RAMON SHANNON

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
5.80	1.40	4.142	4.40	1.00	4.400	6.50	1.20	5.416
6.00	1.20	5.000	15.70	3.00	5.233	3.80	1.00	3.800
14.20	4.00	3.550	7.00	2.60	2.692	10.10	3.30	3.060
4.80	1.00	4.800	3.10	0.90	3.444	6.80	1.20	5.666
8.40	1.20	7.000	5.90	2.20	2.681	4.40	1.30	3.384
9.00	3.90	2.307	8.50	1.50	5.666	5.30	1.40	3.785
8.30	1.40	5.928	7.70	1.60	4.812	6.10	1.10	5.545
5.40	1.20	4.500	6.30	1.50	4.199	5.00	1.00	5.000
8.00	1.00	8.000	5.90	0.90	6.555	3.30	1.50	2.200
7.00	1.10	6.363	9.90	2.00	4.950	4.00	0.40	10.000
0.00	0.00	0.000	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 4.802
LOG AVE OF RATIOS = 0.65541
STANDARD DEVIATION = 1.669
95 PERCENT INTERVAL = 4.802 +/- 0.59

STATION CREEK (CRK) 2B DATE 12-03-70 RECORDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
14.20	3.70	3.837	7.00	2.60	2.692	6.75	2.40	2.812
7.70	1.60	4.812	11.80	2.50	4.720	4.25	0.80	5.312
5.50	1.80	3.055	5.25	1.80	2.916	4.40	1.00	4.400
19.10	3.50	5.457	3.00	1.00	3.000	5.00	1.15	4.347
5.60	2.30	2.434	3.00	1.10	2.727	4.10	2.30	1.782
8.40	1.80	4.666	6.70	3.50	1.914	2.50	1.00	2.500
2.40	1.10	2.181	7.00	1.05	6.666	8.40	1.70	4.941
4.95	1.10	4.500	5.50	4.10	1.341	3.60	0.95	3.789
4.10	2.10	1.952	2.20	0.40	5.500	8.50	5.80	1.465
4.50	1.65	2.727	10.70	2.30	4.652	6.80	2.50	2.720
0.00	0.00	0.000	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 3.527
LOG AVE OF RATIOS = 0.51212
STANDARD DEVIATION = 1.250
95 PERCENT INTERVAL = 3.527 +/- 0.44

STATION CREEK (CRK) 26 DATE 12-03-70 RECORDER RAMON SHANNON (N10E)

LB

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
4.50	1.00	4.500	1.90	6.40	0.296	1.80	0.40	4.500
3.30	0.80	4.125	3.50	1.00	3.500	7.00	1.50	4.666
3.50	1.20	2.916	8.70	1.40	6.214	6.10	3.50	1.742
9.60	2.60	3.692	5.30	1.20	4.416	17.50	2.70	6.481
10.60	2.80	3.785	6.30	1.30	4.846	13.00	3.00	4.333
9.20	1.90	4.842	4.00	0.90	4.444	3.20	1.00	3.200
2.70	0.70	3.857	4.20	0.80	5.250	3.50	0.70	5.000
6.70	1.50	4.466	5.60	2.10	2.666	4.90	0.70	7.000
4.20	0.80	5.250	7.40	1.10	6.727	7.60	1.00	7.600
21.30	2.50	8.520	4.60	1.10	4.181	7.10	1.20	5.916
0.00	0.00	0.000	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 4.631
LOG AVE OF RATIOS = 0.61828
STANDARD DEVIATION = 1.581
95 PERCENT INTERVAL = 4.631 +/- 0.56

STATION RUFF SLOPE (RS) 1 DATE 12-03-70 RECORDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
7.50	1.80	4.166	4.30	1.90	2.263	8.00	3.70	2.162
2.80	1.00	2.800	8.50	2.50	3.400	5.90	1.70	3.470
7.50	2.80	2.678	11.20	3.80	2.947	6.20	4.30	1.441
9.70	2.50	3.880	5.50	0.60	9.166	6.40	3.10	2.064
5.40	2.90	1.862	5.20	2.80	1.857	26.70	5.20	5.134
10.30	1.70	6.058	8.60	2.30	3.739	8.60	2.20	3.909
12.00	3.00	4.000	11.40	0.90	12.666	7.00	1.90	3.684
7.70	2.40	3.208	12.20	2.60	4.692	7.50	1.50	5.000
3.40	0.60	5.666	4.80	1.90	2.526	0.00	0.00	0.000
0.00	0.00	0.000	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 4.017
LOG AVE OF RATIOS = 0.54809
STANDARD DEVIATION = 1.389
95 PERCENT INTERVAL = 4.017 +/- 0.53

STATION RUFF SLOPE (RS) 1 DATE 12-03-70 REOCRDER RAMON SHANNON

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
13.00	4.50	2.888	23.50	6.00	3.916	17.50	4.00	4.375
8.70	2.00	4.350	3.60	1.00	3.600	2.00	0.70	2.857
4.50	0.80	5.625	8.50	2.00	4.250	12.00	3.50	3.428
4.30	1.10	3.909	5.20	1.60	3.250	5.30	1.70	3.117
3.60	0.80	4.500	2.30	0.90	2.555	11.50	4.00	2.875
0.00	0.00	0.000	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 3.699
LOG AVE OF RATIOS = 0.55840
STANDARD DEVIATION = 1.367
95 PERCENT INTERVAL = 3.699 +/- 0.69

STATION RUFF SLOPE (RS) 2 DATE 12-03-70 RECORDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
7.10	1.80	3.944	7.80	56.50	0.138	2.45	1.00	2.450
9.20	2.40	3.833	3.90	1.50	2.599	3.00	0.55	5.454
2.50	0.60	4.166	4.20	0.50	8.400	7.80	2.50	3.119
11.80	2.20	5.363	3.70	4.65	0.795	5.20	1.70	3.058
3.90	1.15	3.391	4.85	1.70	2.852	2.80	1.80	1.555
4.30	2.10	2.047	4.80	1.55	3.096	4.00	1.10	3.636
2.90	1.00	2.900	6.50	2.70	2.407	2.80	0.25	11.200
4.80	1.20	4.000	4.60	1.40	3.285	3.10	0.90	3.444
5.85	1.45	4.034	9.00	3.20	2.812	0.00	0.00	0.000
0.00	0.00	0.000	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 3.615
LOG AVE OF RATIOS = 0.46763
STANDARD DEVIATION = 1.187
95 PERCENT INTERVAL = 3.615 +/- 0.45

STATION RUFF SLOPE (RS) 2 DATE 12-03-70 RECORDER RMAON SHANNON

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
4.00	0.90	4.444	3.50	0.70	5.000	4.10	1.20	3.416
3.10	0.80	3.875	4.60	1.20	3.833	4.50	2.10	2.142
5.00	1.00	5.000	4.20	1.50	2.800	4.30	0.80	5.375
6.50	1.20	5.416	3.80	0.80	4.750	2.20	0.60	3.666
4.00	0.80	5.000	3.80	0.70	5.428	5.30	1.90	2.789
5.60	1.70	3.294	5.10	1.90	2.684	2.20	0.90	2.444
6.50	2.00	3.250	6.30	1.50	4.199	2.20	1.10	2.000
7.20	1.30	5.538	4.20	2.00	2.100	10.30	1.50	6.866
6.00	1.50	4.000	4.70	2.20	2.136	2.10	0.70	3.000
5.00	1.50	3.333	11.50	3.00	3.833	8.00	2.00	4.000
0.00	0.00	0.000	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 3.853
LOG AVE OF RATIOS = 0.56347
STANDARD DEVIATION = 1.377
95 PERCENT INTERVAL = 3.853 +/- 0.49

STATION SUM BANK (SB) 1 DATE 12-02-70 RECORDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
9.20	3.10	2.967	6.20	1.40	4.428	4.20	1.30	3.230
8.30	1.60	5.187	10.80	1.10	9.818	7.10	0.95	7.473
4.40	1.50	2.933	10.00	2.20	4.545	5.10	1.00	5.100
2.50	2.05	1.219	5.20	1.40	3.714	4.40	0.50	8.800
3.20	0.60	5.333	9.80	0.70	14.000	6.90	2.20	3.136
8.00	2.40	3.333	6.50	1.30	5.000	8.00	1.50	5.333
10.50	2.40	4.375	3.20	0.50	6.400	3.70	0.70	5.285
8.60	2.30	3.739	3.80	0.80	4.750	0.00	0.00	0.000
0.00	0.00	0.000	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 5.221
LOG AVE OF RATIOS = 0.66867
STANDARD DEVIATION = 1.771
95 PERCENT INTERVAL = 5.221 +/- 0.72

STATION SUM BANK (SB) 1 DATE 12-03-70 RECORDER RAMON SHANNON

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
5.20	2.00	2.600	3.70	0.80	4.625	3.60	0.50	7.200
12.00	2.00	6.000	6.20	1.40	4.428	12.90	3.00	4.300
6.20	2.10	2.952	4.50	1.00	4.500	4.90	2.00	2.450
4.90	2.00	2.450	4.00	0.80	5.000	3.30	0.90	3.666
8.20	1.40	5.857	4.60	1.20	3.833	3.60	1.40	2.571
3.60	0.70	5.142	5.50	1.00	5.500	6.20	1.20	5.166
3.10	0.70	4.428	4.40	1.40	3.142	3.30	0.10	33.000
14.00	3.80	3.684	13.10	1.50	8.733	6.70	1.40	4.785
7.60	1.80	4.222	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 5.609
LOG AVE OF RATIOS = 0.66245
STANDARD DEVIATION = 1.833
95 PERCENT INTERVAL = 5.609 +/- 0.71

STATION SUM BANK (SB) 2 DATE 12-03-70 RECORDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
26.40	8.10	3.259	10.70	0.90	11.888	12.70	3.50	3.628
13.20	4.10	3.219	13.20	1.60	8.250	6.00	1.10	5.454
4.80	1.10	4.363	2.60	*****	0.000	4.30	0.90	4.777
4.50	0.95	4.736	3.40	0.70	4.857	4.30	1.50	2.866
9.90	2.00	4.950	3.80	1.20	3.166	6.60	4.20	1.571
9.70	3.70	2.621	4.50	1.50	3.000	11.80	3.10	3.806
7.20	2.80	2.571	5.40	1.60	3.375	0.00	0.00	0.000
0.00	0.00	0.000	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 4.118
LOG AVE OF RATIOS = 0.24847
STANDARD DEVIATION = 1.177
95 PERCENT INTERVAL = 4.118 +/- 0.51

STATION SUM BANK (SB) 2 DATE 12-03-70 RECORDER RAMON SHANNON

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
7.90	2.50	3.160	10.00	2.10	4.761	9.50	4.50	2.111
4.10	0.70	5.857	4.10	0.70	5.857	8.50	1.10	7.727
12.00	3.00	4.000	6.50	2.00	3.250	8.50	2.50	3.400
5.70	1.60	3.562	3.90	1.10	3.545	4.30	2.40	1.791
4.00	1.40	2.857	3.60	1.50	2.400	7.80	1.50	5.199
4.70	1.20	3.916	9.50	1.80	5.277	3.60	1.50	2.400
7.60	1.90	4.000	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 3.951
LOG AVE OF RATIOS = 0.56711
STANDARD DEVIATION = 1.413
95 PERCENT INTERVAL = 3.951 +/- 0.63

STATION TANK (TK) 1 DATE 12-04-70 RECORDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
8.80	3.80	2.315	4.80	3.50	1.371	1.70	1.20	1.416
2.00	1.70	1.176	1.80	0.90	2.000	6.80	3.20	2.125
4.60	2.40	1.916	2.20	2.00	1.100	2.60	1.80	1.444
4.70	1.70	2.764	3.60	3.30	1.090	4.40	2.60	1.692
2.50	0.90	2.777	7.90	4.10	1.926	3.65	4.00	0.912
2.30	1.10	2.090	4.70	1.70	2.764	2.90	1.35	2.148
4.45	1.80	2.472	7.00	3.20	2.187	0.00	0.00	0.000
0.00	0.00	0.000	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 1.884
LOG AVE OF RATIOS = 0.25297
STANDARD DEVIATION = 0.642
95 PERCENT INTERVAL = 1.884 +/- 0.28

STATION TANK (TK) 1 DATE 12-04-70 RECORDER RAMON SHANNON

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
6.90	4.10	1.682	4.50	1.60	2.812	8.30	2.70	3.074
7.50	1.10	6.818	3.00	1.50	2.000	2.20	0.70	3.142
5.30	3.00	1.766	4.00	2.40	1.666	5.10	2.20	2.318
3.20	0.80	4.000	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 2.928
LOG AVE OF RATIOS = 0.42310
STANDARD DEVIATION = 1.067
95 PERCENT INTERVAL = 2.928 +/- 0.66

STATION TANK (TK) 2 DATE 12-04-70 RECORDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
4.30	2.20	1.954	8.65	4.70	1.840	12.30	3.00	4.100
4.70	1.10	4.272	2.10	1.05	2.000	3.20	1.40	2.285
47.10	12.70	3.708	8.60	2.50	3.440	8.00	4.10	1.951
4.30	2.30	1.869	5.90	2.80	2.107	14.60	4.50	3.244
5.60	2.90	1.931	3.30	1.70	1.941	20.20	9.00	2.244
9.10	4.00	2.275	9.70	5.30	1.830	8.30	3.60	2.305
10.40	3.20	3.250	11.20	1.10	10.181	6.60	1.30	5.076
7.40	2.10	3.523	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 3.060
LOG AVE OF RATIOS = 0.43825
STANDARD DEVIATION = 1.080
95 PERCENT INTERVAL = 3.060 +/- 0.45

STATION TANK (TK) 2 DATE 12-04-70 RECORDER RAMON SHANNON

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
8.50	0.70	12.142	18.00	4.00	4.500	9.40	2.00	4.700
10.20	3.50	2.914	10.50	7.90	1.329	4.60	1.70	2.705
1.50	1.50	1.000	5.80	1.50	3.866	4.60	2.00	2.300
3.90	1.10	3.545	4.80	1.00	4.800	9.30	1.40	6.642
10.00	5.50	1.818	3.10	1.20	2.583	2.60	1.10	2.363
8.00	1.80	4.444	3.00	2.00	1.500	8.30	1.00	8.300
8.60	2.50	3.440	10.20	3.00	3.400	3.60	3.10	1.161
10.50	3.50	3.000	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 3.748
LOG AVE OF RATIOS = 0.49230
STANDARD DEVIATION = 1.267
95 PERCENT INTERVAL = 3.748 +/- 0.52

STATION-POWER LINE (PL) 1 DATE 12-03-70 RECORDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
8.40	1.90	4.421	2.50	0.30	8.333	0.90	0.20	4.500
5.50	1.50	3.666	4.00	0.90	4.444	9.60	3.30	2.909
3.80	1.60	2.375	5.10	2.00	2.550	1.90	0.60	3.166
10.50	3.30	3.181	5.00	1.60	3.125	2.20	1.30	1.692
7.10	1.80	3.944	2.00	1.20	1.666	4.40	2.30	1.913
2.60	1.10	2.363	1.20	0.90	1.333	7.10	3.25	2.184
4.80	2.20	2.181	4.80	0.60	8.000	2.20	0.30	7.333
5.30	2.30	2.304	3.50	1.00	3.500	5.50	1.35	4.074
1.80	0.20	9.000	1.50	1.00	1.500	5.50	2.00	2.750
1.50	0.30	5.000	3.20	1.40	2.285	1.70	1.20	1.416
4.90	1.75	2.800	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 3.545
LOG AVE OF RATIOS = 0.49004
STANDARD DEVIATION = 1.223
95 PERCENT INTERVAL = 3.545 +/- 0.43

STATION POWER LINE (PL) 2 DATE 12-04-70 RECORDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
3.90	1.00	3.900	14.00	1.10	12.727	13.50	4.00	3.375
4.20	1.50	2.800	5.50	2.00	2.750	2.50	0.60	4.166
16.10	0.20	80.500	7.20	2.20	3.272	2.80	1.40	2.000
6.10	2.10	2.904	12.10	4.85	2.494	7.50	1.90	3.947
2.00	0.40	5.000	2.20	0.50	4.400	3.20	0.70	4.571
3.50	1.90	1.842	4.40	0.90	4.888	4.90	1.00	4.900
28.50	2.60	10.961	3.50	1.00	3.500	38.00	7.60	5.000
5.50	2.10	2.619	3.80	0.80	4.750	20.50	4.20	4.880
10.70	4.90	2.183	7.80	1.80	4.333	6.20	2.00	3.100
9.15	1.50	6.100	8.20	4.00	2.050	9.20	2.70	3.407
4.60	1.10	4.181	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 6.693
LOG AVE OF RATIOS = 0.62387
STANDARD DEVIATION = 1.954
95 PERCENT INTERVAL = 6.693 +/- 0.68

STATION DEVIL'S CAN. EAST DCE 1A DATE 12-06-70 RECORDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
3.05	0.50	6.100	3.80	2.40	1.583	4.30	4.40	0.977
5.10	1.15	4.434	2.30	1.00	2.300	3.10	2.10	1.476
4.50	1.30	3.461	1.20	1.05	1.142	2.30	0.60	3.833
5.30	3.90	1.358	2.75	1.35	2.037	3.20	3.10	1.032
4.55	0.80	5.687	17.30	3.85	4.493	10.70	2.80	3.821
2.00	1.40	1.428	3.20	1.90	1.684	3.35	1.20	2.791
1.35	1.20	1.125	5.50	0.90	6.111	4.00	2.20	1.818
9.20	3.50	2.628	3.15	3.30	0.954	5.60	3.15	1.777
12.50	1.90	6.578	6.50	1.20	5.416	4.60	2.10	2.190
9.40	2.05	4.585	3.50	1.70	2.058	2.15	1.00	2.150
0.00	0.00	0.000	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 2.901
LOG AVE OF RATIOS = 0.38508
STANDARD DEVIATION = 0.965
95 PERCENT INTERVAL = 2.901 +/- 0.34

STATION DEVIL'S CAN. EAST DCE 1B DATE 12-06-70 RECORDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
4.00	1.90	2.105	6.70	0.70	9.571	2.70	2.40	1.125
4.30	1.20	3.583	8.20	4.15	1.975	4.60	1.20	3.833
2.40	1.15	2.086	6.10	2.40	2.541	2.25	1.90	1.184
8.70	4.00	2.175	3.00	2.45	1.224	5.00	1.50	3.333
2.10	0.80	2.625	2.10	0.50	4.200	13.40	3.80	3.526
9.50	1.60	5.937	3.50	1.65	2.121	8.10	1.60	5.062
4.70	1.80	2.611	6.20	2.20	2.818	6.90	1.50	4.600
4.40	2.10	2.095	8.30	3.20	2.593	5.50	1.60	3.437
7.90	2.90	2.724	5.00	2.05	2.439	3.80	1.35	2.814
4.10	1.50	2.733	4.00	1.65	2.424	5.30	2.20	2.409
1.50	1.25	1.200	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 3.003
LOG AVE OF RATIOS = 0.42854
STANDARD DEVIATION = 1.048
95 PERCENT INTERVAL = 3.003 +/- 0.36

STATION DEVIL'S CAN. EAST DCE 1C DATE 12-06-70 RECORDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
11.00	5.60	1.964	4.65	1.30	3.576	3.00	2.70	1.111
5.90	4.00	1.475	2.20	1.90	1.157	9.70	2.15	4.511
14.20	7.20	1.972	13.50	3.65	3.698	2.75	0.80	3.437
3.00	0.80	3.750	1.90	2.20	0.863	7.60	1.70	4.470
1.60	0.60	2.666	6.80	3.50	1.942	3.70	1.80	2.055
9.40	2.30	4.086	6.60	1.55	4.258	6.10	1.80	3.388
5.00	0.90	5.555	6.90	3.10	2.225	3.20	2.00	1.600
5.90	3.90	1.512	4.40	3.80	1.157	11.80	6.80	1.735
1.50	1.55	0.967	6.50	2.10	3.095	14.00	2.10	6.666
13.00	8.10	1.604	6.60	4.00	1.650	8.80	3.20	2.750
4.60	1.00	4.600	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 2.758
LOG AVE OF RATIOS = 0.37876
STANDARD DEVIATION = 0.934
95 PERCENT INTERVAL = 2.758 +/- 0.32

STATION DEVIL'S CAN. EAST DCE 2C DATE 12-06-70 RECORDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
9.20	4.50	2.044	3.00	1.40	2.142	3.20	1.60	2.000
2.90	1.30	2.230	10.80	2.10	5.142	5.90	2.00	2.950
8.50	2.60	3.269	8.80	2.80	3.142	7.50	1.60	4.687
6.90	1.50	4.600	6.10	1.70	3.588	1.65	0.90	1.833
2.60	1.15	2.260	4.10	2.60	1.576	7.10	2.15	3.302
7.50	3.40	2.205	5.90	2.80	2.107	7.50	2.00	3.750
3.60	2.20	1.636	9.80	2.90	3.379	2.00	1.15	1.739
1.80	0.55	3.272	7.00	2.30	3.043	5.80	1.80	3.222
10.80	1.80	6.000	2.30	3.10	0.741	2.80	1.40	2.000
7.00	1.80	3.888	26.50	6.40	4.140	3.10	2.40	1.291
3.50	1.50	2.333	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 2.887
LOG AVE OF RATIOS = 0.42170
STANDARD DEVIATION = 1.018
95 PERCENT INTERVAL = 2.887 +/- 0.35

STATION DEVIL'S CAN. EAST DCE 2B DATE 12-06-70 RECORDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
4.50	3.20	1.406	13.10	1.50	8.733	3.90	2.00	1.950
2.60	0.90	2.888	6.00	2.21	2.714	6.80	1.90	3.578
4.10	1.40	2.928	2.30	1.80	1.277	10.50	3.80	2.763
5.00	1.20	4.166	6.80	1.00	6.800	6.00	3.45	1.739
3.50	1.90	1.842	7.10	1.50	4.733	1.70	1.60	1.062
7.60	2.70	2.814	5.40	1.00	5.400	8.80	2.90	3.034
2.70	1.10	2.454	3.20	0.60	5.333	2.60	0.70	3.714
5.00	3.00	1.666	3.55	0.70	5.071	2.30	1.50	1.533
2.80	0.70	4.000	1.20	0.90	1.333	3.60	1.20	3.000
4.80	1.70	2.823	1.45	1.20	1.208	2.35	0.90	2.611
1.80	2.00	0.900	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 3.080
LOG AVE OF RATIOS = 0.42170
STANDARD DEVIATION = 1.047
95 PERCENT INTERVAL = 3.080 +/- 0.36

STATION DEVIL'S CAN. EAST DCE 2A DATE 12-06-70 RECORDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
6.00	2.10	2.857	11.30	3.70	3.054	5.90	1.00	5.900
2.50	2.40	1.041	1.50	1.20	1.250	5.15	2.10	2.452
14.20	6.20	2.290	3.10	1.10	2.818	9.80	4.20	2.333
3.60	1.60	2.250	17.20	4.00	4.300	4.30	1.60	2.687
6.90	2.60	2.653	3.10	3.00	1.033	6.20	1.65	3.757
10.10	3.80	2.657	11.20	3.70	3.027	5.00	1.00	5.000
3.35	0.60	5.583	7.00	2.80	2.500	2.75	0.65	4.230
2.20	0.70	3.142	4.00	2.20	1.818	3.90	1.20	3.250
3.70	1.50	2.466	4.20	1.10	3.818	5.70	1.30	4.384
4.70	1.00	4.700	3.25	1.25	2.600	6.30	1.50	4.199
3.75	0.90	4.166	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 3.168
LOG AVE OF RATIOS = 0.46491
STANDARD DEVIATION = 1.123
95 PERCENT INTERVAL = 3.168 +/- 0.39

STATION DEVIL'S CAN. EAST DCE 3 DATE 12-06-70

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
26.10	11.00	2.372	8.60	3.00	2.866	7.70	1.50	5.133
6.80	1.60	4.250	5.40	1.00	5.400	3.00	1.35	2.222
3.10	1.50	2.066	6.90	1.70	4.058	6.80	3.00	2.266
4.60	1.08	4.259	20.00	7.00	2.857	8.00	5.10	1.568
8.80	1.70	5.176	8.50	2.70	3.148	4.70	1.05	4.476
7.60	2.50	3.040	4.20	1.40	3.000	4.60	2.50	1.840
3.40	0.90	3.777	4.60	1.50	3.066	3.50	1.50	2.333
5.10	3.50	1.457	5.70	2.70	2.111	3.60	1.50	2.400
6.50	2.10	3.095	4.50	2.00	2.250	3.70	1.10	3.363
3.20	0.80	4.000	1.40	1.70	0.823	2.60	0.90	2.888
6.70	2.60	2.576	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 3.037
LOG AVE OF RATIOS = 0.45024
STANDARD DEVIATION = 1.082
95 PERCENT INTERVAL = 3.037 +/- 0.38

STATION DEVIL'S CAN. EAST DCE 4 DATE 12-06-70 RECORDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
3.20	1.30	2.461	7.20	3.30	2.181	6.20	1.90	3.263
7.70	2.40	3.208	7.10	3.10	2.290	13.70	3.90	3.512
3.50	3.00	1.166	4.00	3.30	1.212	4.40	4.50	0.977
2.30	1.50	1.533	6.10	2.00	3.050	4.00	0.95	4.210
10.30	4.00	2.575	5.00	1.10	4.545	5.00	0.10	50.000
2.00	0.90	2.222	3.50	1.20	2.916	12.20	7.80	1.564
4.75	2.10	2.261	5.00	1.60	3.125	2.20	1.10	2.000
5.30	1.00	5.300	6.60	1.80	3.666	3.30	1.10	3.000
5.50	1.60	3.437	14.20	5.60	2.535	4.50	2.00	2.250
9.00	2.00	4.500	4.00	1.10	3.636	3.00	1.30	2.307
4.40	1.40	3.142	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 4.324
LOG AVE OF RATIOS = 0.45634
STANDARD DEVIATION = 1.319
95 PERCENT INTERVAL = 4.324 +/- 0.46

TATION DEVIL'S CAN. EAST DCE 5 DATE 12-06-70 RECORDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
8.40	2.60	3.230	2.30	2.30	1.000	7.40	3.10	2.387
3.80	1.80	2.111	10.00	1.10	9.090	5.10	1.70	3.000
10.80	3.80	2.842	6.30	1.90	3.315	3.20	1.00	3.200
1.60	0.80	2.000	5.10	1.60	3.187	12.00	2.00	6.000
11.90	2.20	5.409	10.80	2.60	4.153	8.80	2.00	4.400
2.50	0.80	3.125	4.20	3.60	1.166	5.00	1.30	3.846
5.20	2.80	1.857	1.70	0.20	8.500	3.20	0.70	4.571
4.20	2.00	2.100	2.80	2.20	1.272	8.00	2.50	3.200
1.90	1.50	1.266	8.10	1.40	5.785	2.95	1.50	1.966
2.70	0.60	4.500	3.00	2.10	1.428	1.00	0.90	1.111
1.10	0.90	1.222	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 3.298
LOG AVE OF RATIOS = 0.44327
STANDARD DEVIATION = 1.113
95 PERCENT INTERVAL = 3.298 +/- 0.39

ASARCO DACITE DATA

Individual(s) Readings - Ratios
Corrected Data

George S. Barnett April 20, 1971

STATION SHAFT SH1 DATE 11-12-70 RECORDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
14.25	2.20	6.477	2.20	0.50	4.400	6.20	1.00	6.200
5.50	1.70	3.235	1.10	0.20	5.500	3.40	0.50	6.800
5.90	0.50	11.800	5.80	1.10	5.272	3.70	0.50	7.400
10.00	0.80	12.500	10.80	1.80	6.000	6.20	3.20	1.937
6.00	0.85	7.058	15.80	2.40	6.583	3.90	0.60	6.500
5.70	1.50	3.800	6.40	1.70	3.764	3.00	1.60	1.875
5.00	1.10	4.545	3.30	1.50	2.200	8.40	1.50	5.600
7.20	2.00	3.600	11.35	3.70	3.067	7.30	2.00	3.650
11.70	3.80	3.078	15.40	2.60	5.923	8.30	1.40	5.928
12.10	1.90	6.368	5.80	2.30	2.521	4.00	0.50	8.000
0.00	0.00	0.000	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 5.386
LOG AVE OF RATIOS = 0.68534
STANDARD DEVIATION = 1.813
95 PERCENT INTERVAL = 5.386 +/- 0.64

ASARCO DACITE DATA SH-1 SAMPLES TAKEN 11/12/70 BY RAMON SHANNON

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
1.50	0.50	3.000	3.20	0.70	4.571	1.90	0.40	4.750
2.60	0.70	3.714	4.50	0.80	5.625	6.00	1.00	6.000
2.60	0.40	6.500	2.40	0.40	6.000	1.50	0.50	3.000
4.50	1.70	2.647	2.20	0.40	5.500	2.80	1.00	2.800
1.40	0.40	3.500	1.80	0.40	4.500	0.00	0.00	0.000
0.00	0.00	0.000	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 4.436
LOG AVE OF RATIOS = 0.62769
STANDARD DEVIATION = 1.598
95 PERCENT INTERVAL = 4.436 +/- 0.83

STATION SHAFT SH2 DATE 11-12-70 RECORDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
3.50	0.80	4.375	3.30	1.20	2.750	9.00	1.50	6.000
9.50	2.60	3.653	4.20	1.10	3.818	5.30	1.60	3.312
3.40	1.20	2.833	10.50	3.10	3.387	5.00	0.70	7.142
4.00	1.00	4.000	9.00	1.10	8.181	2.70	1.10	2.454
4.70	1.20	3.916	1.70	0.70	2.428	7.20	1.40	5.142
2.80	1.10	2.545	3.50	0.85	4.117	6.00	2.20	2.727
6.20	1.10	5.636	4.60	1.90	2.421	2.70	0.35	7.714
3.50	0.80	4.375	4.40	1.20	3.666	2.50	0.45	5.555
3.20	1.00	3.200	3.40	0.70	4.857	2.50	0.35	7.142
6.10	1.50	4.066	6.20	0.70	8.857	3.20	1.10	2.909
0.00	0.00	0.000	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 4.439
LOG AVE OF RATIOS = 0.61491
STANDARD DEVIATION = 1.550
95 PERCENT INTERVAL = 4.439 +/- 0.55

STATION SHAFT SH2 DATE 11-12-70 RECORDER RAMON SHANNON

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
2.50	0.40	6.250	4.00	0.50	8.000	3.30	0.80	4.125
5.00	0.80	6.250	3.40	1.10	3.090	5.60	2.00	2.800
3.20	0.90	3.555	4.00	1.70	2.352	2.90	0.60	4.833
2.50	0.70	3.571	3.10	0.50	6.200	4.80	1.50	3.200
0.34	0.40	0.850	4.50	0.70	6.428	4.10	8.00	0.512
0.00	0.00	0.000	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 4.134
LOG AVE OF RATIOS = 0.53012
STANDARD DEVIATION = 1.392
95 PERCENT INTERVAL = 4.134 +/- 0.70

TION SHAFT SH3 DATE 11-12-70 RECORDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
9.70	1.30	7.461	10.70	1.40	7.642	6.80	1.50	4.533
4.00	0.60	6.666	9.50	1.50	6.333	9.20	0.95	9.684
3.00	0.60	5.000	5.50	1.20	4.583	4.20	0.25	16.800
5.40	1.70	3.176	5.10	1.15	4.434	8.50	0.95	8.947
3.20	1.10	2.909	7.10	1.20	5.916	3.00	0.80	3.750
3.00	1.00	3.000	5.50	0.50	11.000	4.10	1.00	4.100
12.15	3.10	3.919	4.30	0.50	8.600	15.00	2.70	5.555
2.80	4.50	0.622	4.90	1.00	4.900	3.40	1.10	3.090
2.50	0.40	6.250	4.70	1.65	2.848	7.60	1.80	4.222
5.50	0.60	9.166	2.40	0.90	2.666	0.00	0.00	0.000
0.00	0.00	0.000	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 5.785
LOG AVE OF RATIOS = 0.69524
STANDARD DEVIATION = 1.896
95 PERCENT INTERVAL = 5.785 +/- 0.69

STATION SHAFT SH 3 DATE 11-12-70 RECORDER RAMON SHANNON

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
3.70	0.70	5.285	2.30	0.60	3.833	4.70	0.40	11.750
1.80	0.70	2.571	3.30	0.80	4.125	1.70	0.60	2.833
3.00	0.60	5.000	2.30	0.40	5.750	2.70	0.70	3.857
3.30	0.40	8.250	3.00	0.70	4.285	4.20	0.80	5.250
3.40	0.70	4.857	2.90	0.60	4.833	3.30	0.70	4.714
2.70	0.60	4.500	1.40	0.20	7.000	2.70	0.60	4.500
1.20	0.30	4.000	2.00	0.40	5.000	3.70	1.30	2.846
2.10	0.30	7.000	1.50	0.60	2.500	4.00	0.60	6.666
2.60	0.60	4.333	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 5.021
LOG AVE OF RATIOS = 0.67290
STANDARD DEVIATION = 1.738
95 PERCENT INTERVAL = 5.021 +/- 0.68

LOCATION SUTTON'S SUMMIT SS 1 DATE 11-24-70 RECORDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
6.60	1.20	5.500	13.60	1.75	7.771	2.50	0.80	3.125
7.50	2.20	3.409	6.00	1.80	3.333	2.20	0.60	3.666
2.10	0.70	3.000	2.10	0.30	7.000	1.40	0.40	3.500
3.40	0.60	5.666	4.00	0.70	5.714	35.00	6.60	5.303
21.10	4.30	4.906	16.70	3.70	4.513	7.80	2.10	3.714
3.50	0.80	4.375	6.10	1.00	6.100	2.90	2.90	1.000
3.20	3.40	0.941	9.00	5.20	1.730	3.40	3.25	1.046
3.40	1.40	2.428	2.20	0.70	3.142	3.60	1.40	2.571
3.40	1.30	2.615	2.40	1.30	1.846	1.70	0.40	4.250
5.00	2.80	1.785	2.70	0.30	9.000	5.90	1.90	3.105
2.10	1.70	1.235	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 3.783
LOG AVE OF RATIOS = 0.51014
STANDARD DEVIATION = 1.287
95 PERCENT INTERVAL = 3.783 +/- 0.45

STATION-SUTTON'S SUMMIT (SS) 2 DATE 11-24-70 RECORDER RAMON SHANNON

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
8.50	3.40	2.500	4.00	1.10	3.636	4.80	1.40	3.428
6.00	1.10	5.454	2.20	0.90	2.444	2.60	0.80	3.250
3.50	1.30	2.692	5.00	1.80	2.777	3.70	1.00	3.700
6.00	1.90	3.157	11.50	4.00	2.875	6.60	2.20	3.000
4.90	1.10	4.454	1.80	0.50	3.600	3.40	0.60	5.666
7.00	1.50	4.666	6.00	1.00	6.000	2.10	0.60	3.500
8.00	2.00	4.000	4.70	0.80	5.875	3.50	0.40	8.750
13.50	2.40	5.625	9.50	2.00	4.750	5.00	1.00	5.000
2.50	0.50	5.000	7.40	1.20	6.166	5.50	1.20	4.583
6.30	2.00	3.150	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 4.275
LOG AVE OF RATIOS = 0.60873
STANDARD DEVIATION = 1.514
95 PERCENT INTERVAL = 4.275 +/- 0.56

STATION SUTTON'S SUMMIT SS 3 DATE 11-24-70 RECORDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
5.80	1.60	3.625	3.50	1.70	2.058	14.50	2.40	6.041
10.70	1.20	8.916	8.40	0.25	33.600	5.10	1.40	3.642
7.80	2.20	3.545	3.80	1.00	3.800	12.00	3.40	3.529
4.50	1.80	2.500	6.30	1.40	4.500	3.80	0.25	15.200
2.80	0.20	14.000	4.00	0.80	5.000	3.50	0.55	6.363
2.50	0.30	8.333	4.70	0.55	8.545	9.40	1.75	5.371
7.80	1.40	5.571	2.15	0.50	4.300	5.00	1.10	4.545
7.20	1.00	7.200	3.50	0.23	15.217	5.00	0.55	9.090
6.80	1.10	6.181	2.25	0.50	4.500	4.20	0.55	7.636
2.40	0.50	4.800	1.80	0.45	4.000	8.00	2.30	3.478
0.00	0.00	0.000	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 7.169
LOG AVE OF RATIOS = 0.76735
STANDARD DEVIATION = 2.239
95 PERCENT INTERVAL = 7.169 +/- 0.80

STATION-SUTTON'S SUMMIT (SS) 3 DATE 11-24 70 RECORDER RAMON SHANNON

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
14.00	3.00	4.666	8.50	2.00	4.250	3.80	1.40	2.714
9.00	2.50	3.600	4.90	1.00	4.900	5.20	0.70	7.428
1.20	0.50	2.400	8.00	2.50	3.200	3.40	1.20	2.833
7.80	1.80	4.333	8.00	1.50	5.333	3.70	0.80	4.625
12.00	1.60	7.500	4.70	0.60	7.833	6.00	0.70	8.571
6.50	0.60	10.833	5.10	3.00	1.700	8.00	1.00	8.000
5.40	2.00	2.700	5.50	2.00	2.750	3.00	0.80	3.750
7.70	1.50	5.133	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 4.957
LOG AVE OF RATIOS = 0.64729
STANDARD DEVIATION = 1.696
95 PERCENT INTERVAL = 4.957 +/- 0.70

STATION JI RANCH JI 1 DATE 11-24-70 RECORDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
9.00	1.20	7.500	5.00	2.80	1.785	3.00	1.05	2.857
4.30	1.00	4.300	2.00	0.70	2.857	13.00	4.20	3.095
6.10	3.00	2.033	2.50	1.30	1.923	9.10	3.60	2.527
11.85	5.30	2.235	5.60	4.50	1.244	3.30	3.00	1.100
3.70	2.90	1.275	6.55	1.80	3.638	9.10	1.10	8.272
11.30	3.80	2.973	3.50	0.80	4.375	7.70	2.40	3.208
3.90	1.00	3.900	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 3.216
LOG AVE OF RATIOS = 0.44419
STANDARD DEVIATION = 1.114
95 PERCENT INTERVAL = 3.216 +/- 0.50

STATION-JJ RANCH (JI) 1 DATE 12-24-70 RECORDER-RAMON SHANNON

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
5.30	1.10	4.818	22.00	6.00	3.666	1.70	0.30	5.666
7.00	1.50	4.666	6.50	3.50	1.857	4.50	1.20	3.750
2.30	0.70	3.285	5.40	0.90	6.000	4.60	0.70	6.571
7.50	0.60	12.500	3.70	0.80	4.625	6.00	1.50	4.000
7.00	0.10	70.000	1.80	1.30	1.384	4.80	1.20	4.000
8.80	1.30	6.769	2.50	1.70	1.470	1.70	0.80	2.125
4.50	1.00	4.500	6.30	1.80	3.500	2.80	0.50	5.600
4.10	0.90	4.555	4.90	0.40	12.250	4.90	1.10	4.454
4.50	0.90	5.000	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 7.480
LOG AVE OF RATIOS = 0.67770
STANDARD DEVIATION = 2.165
95 PERCENT INTERVAL = 7.480 +/- 0.84

STATION JI RANCH JI 2 DATE 11-24-70 RECORDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
11.60	7.00	1.657	8.00	1.00	8.000	4.20	0.70	6.000
16.20	7.50	2.160	2.70	0.50	5.400	15.10	6.50	2.323
10.00	4.00	2.500	17.00	3.20	5.312	14.40	4.10	3.512
17.80	3.20	5.562	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 4.242
LOG AVE OF RATIOS = 0.57475
STANDARD DEVIATION = 1.512
95 PERCENT INTERVAL = 4.242 +/- 0.93

STATION-JJ RANCH (JI) 2 DATE 11-24-70 RECORDER-RAMON SHANNON

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
7.30	2.30	3.173	8.00	3.00	2.666	7.40	0.70	10.571
14.00	5.00	2.800	17.10	3.50	4.885	13.50	8.80	1.534
10.60	4.10	2.585	7.20	2.00	3.600	9.30	3.40	2.735
17.50	4.60	3.804	8.90	1.30	6.846	7.10	0.80	8.875
10.70	1.50	7.133	12.20	2.70	4.518	8.20	0.85	9.647
20.80	3.20	6.500	18.20	4.50	4.044	13.20	5.10	2.588
15.30	2.00	7.650	7.90	2.40	3.291	4.70	2.10	2.238
4.40	0.80	5.500	2.20	0.80	2.750	11.70	3.90	3.000
9.50	3.50	2.714	2.10	1.05	2.000	6.90	1.10	6.272
6.30	2.60	2.423	7.20	1.80	4.000	0.00	0.00	0.000
0.00	0.00	0.000	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 4.494
LOG AVE OF RATIOS = 0.59638
STANDARD DEVIATION = 1.535
95 PERCENT INTERVAL = 4.494 +/- 0.55

STATION OAK FLAT (OF) 1 DATE 11-25-70 RECORDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
3.40	0.60	5.666	2.50	1.15	2.173	9.20	3.30	2.787
2.50	1.00	2.500	2.90	1.10	2.636	2.20	2.10	1.047
10.50	6.10	1.721	11.50	7.20	1.597	13.80	4.80	2.875
17.10	9.80	1.744	13.10	3.60	3.638	11.90	3.90	3.051
14.40	3.60	4.000	10.30	5.80	1.775	7.20	3.20	2.250
12.90	6.40	2.015	8.50	5.00	1.700	6.00	4.40	1.363
9.00	5.10	1.764	26.20	9.60	2.729	4.15	3.80	1.092
4.60	4.00	1.150	4.00	4.10	0.975	4.40	2.60	1.692
3.20	4.20	0.761	13.30	7.20	1.847	7.20	3.80	1.894
3.50	2.90	1.206	2.40	1.80	1.333	0.00	0.00	0.000
0.00	0.00	0.000	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 2.103
LOG AVE OF RATIOS = 0.27811
STANDARD DEVIATION = 0.697
95 PERCENT INTERVAL = 2.103 +/- 0.25

STATION OAK FLAT (OF) 2 DATE 11-25-70 RECORDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
6.80	2.20	3.090	1.90	0.75	2.533	3.50	1.10	3.181
3.50	1.00	3.500	1.50	0.80	1.875	2.60	1.45	1.793
6.20	2.50	2.480	3.90	2.30	1.695	6.70	2.50	2.680
3.00	2.90	1.034	5.60	2.90	1.931	1.70	2.30	0.739
4.30	1.50	2.866	2.30	1.10	2.090	8.35	2.80	2.982
4.30	4.00	1.075	4.00	1.25	3.200	3.70	0.90	4.111
8.00	4.50	1.777	9.20	4.20	2.190	4.30	2.30	1.869
2.50	1.10	2.272	3.50	1.70	2.058	7.10	2.10	3.380
6.50	3.30	1.969	9.50	2.80	3.392	4.70	1.70	2.764
4.50	3.60	1.250	5.80	2.60	2.230	0.00	0.00	0.000
0.00	0.00	0.000	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 2.345
LOG AVE OF RATIOS = 0.34014
STANDARD DEVIATION = 0.822
95 PERCENT INTERVAL = 2.345 +/- 0.29

STATION OAK FLAT (OF) 3 DATE 11-25-70 RECORDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
7.50	1.90	3.947	8.10	1.25	6.480	7.50	3.20	2.343
5.55	1.75	3.171	3.70	2.00	1.850	3.40	1.35	2.518
3.50	1.20	2.916	8.30	3.00	2.766	4.20	2.30	1.826
6.00	2.80	2.142	3.60	1.40	2.571	4.55	1.80	2.527
9.30	3.70	2.513	3.10	1.30	2.384	4.00	1.85	2.162
3.50	1.20	2.916	3.20	1.20	2.666	1.30	1.55	0.838
4.30	2.20	1.954	2.40	1.15	2.086	3.10	1.10	2.818
8.10	3.80	2.131	2.70	1.40	1.928	2.00	2.10	0.952
4.10	2.20	1.863	3.30	1.60	2.062	11.20	4.70	2.382
0.00	0.00	0.000	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 2.471
LOG AVE OF RATIOS = 0.36302
STANDARD DEVIATION = 0.876
95 PERCENT INTERVAL = 2.471 +/- 0.33

STATION THROW NO. (235) 1 DATE 11-25-70 RECORDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
12.20	7.60	1.605	11.20	4.60	2.434	6.00	2.60	2.307
12.90	7.40	1.743	5.20	1.50	3.466	3.10	0.70	4.428
14.40	5.50	2.618	8.40	4.70	1.787	6.10	1.50	4.066
1.90	0.80	2.375	6.80	2.90	2.344	10.60	3.80	2.789
2.90	2.10	1.380	8.70	3.50	2.485	8.60	2.70	3.185
2.50	2.20	1.136	4.30	1.90	2.263	4.50	0.90	5.000
6.80	2.50	2.720	3.30	0.90	3.666	7.70	2.60	2.961
10.70	6.10	1.754	8.90	5.70	1.561	9.90	4.00	2.475
4.70	2.00	2.350	3.50	2.10	1.666	7.60	3.00	2.533
0.00	0.00	0.000	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 2.559
LOG AVE OF RATIOS = 0.38146
STANDARD DEVIATION = 0.915
95 PERCENT INTERVAL = 2.559 +/- 0.34

STATION THROW NO. (235) 2 DATE 11-25-70 RECORDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
4.20	1.00	4.200	5.00	2.15	2.325	2.80	1.05	2.666
18.60	11.30	1.646	12.30	5.20	2.365	12.40	5.50	2.254
12.50	5.60	2.232	9.20	4.50	2.044	12.20	7.30	1.671
20.60	12.00	1.716	7.10	3.90	1.820	8.50	4.90	1.734
9.10	4.10	2.219	16.70	6.80	2.455	13.50	2.00	6.750
7.20	2.40	3.000	5.60	3.10	1.806	10.70	4.80	2.229
2.30	1.30	1.769	10.40	4.00	2.600	8.00	4.30	1.860
10.70	7.40	1.445	5.10	1.40	3.642	8.30	2.20	3.772
10.60	3.50	3.028	5.40	3.50	1.542	7.00	4.80	1.458
8.60	3.70	2.324	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 2.449
LOG AVE OF RATIOS = 0.35906
STANDARD DEVIATION = 0.868
95 PERCENT INTERVAL = 2.449 +/- 0.32

STATION CREEK (CRK) 0 DATE 12-0^ ·70 RECORDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
9.80	3.30	2.969	5.80	1.30	4.461	5.00	2.45	2.040
5.60	0.70	8.000	4.60	2.15	2.139	8.20	1.50	5.466
4.60	2.60	1.769	4.90	1.60	3.062	8.00	3.80	2.105
8.50	3.20	2.656	5.90	1.00	5.900	6.30	1.10	5.727
6.50	1.45	4.482	6.45	2.20	2.931	5.10	1.40	3.642
7.70	3.40	2.264	1.90	2.10	0.904	4.50	0.60	7.500
4.50	1.10	4.090	7.45	1.70	4.382	21.30	5.50	3.872
11.70	6.30	1.857	9.70	2.90	3.344	5.20	1.90	2.736
5.00	1.20	4.166	4.30	1.50	2.866	4.30	1.80	2.388
5.70	1.50	3.800	2.90	1.05	2.761	2.00	0.75	2.666
7.70	3.40	2.264	4.80	1.00	4.800	6.80	2.80	2.428
6.50	1.70	3.823	3.50	1.40	2.500	6.30	2.10	3.000
7.80	3.90	2.000	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 3.453
LOG AVE OF RATIOS = 0.49822
STANDARD DEVIATION = 1.215
95 PERCENT INTERVAL = 3.453 +/- 0.39

STATION CREEK (CRK) 1 DATE 12-03-70 RECORDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
8.00	1.90	4.210	2.60	0.70	3.714	4.30	1.40	3.071
7.90	1.80	4.388	4.20	4.60	0.913	4.20	2.70	1.555
6.00	2.90	2.068	5.00	1.25	4.000	3.00	3.00	1.000
3.20	2.40	1.333	10.00	3.60	2.777	6.00	1.30	4.615
1.80	1.30	1.384	2.10	1.15	1.826	4.70	4.30	1.093
2.30	1.25	1.840	5.50	5.20	1.057	28.90	7.30	3.958
2.10	1.60	1.312	3.50	0.45	7.777	2.90	2.30	1.260
2.20	0.90	2.444	5.40	1.60	3.375	10.20	4.10	2.487
8.20	1.60	5.125	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 2.743
LOG AVE OF RATIOS = 0.36346
STANDARD DEVIATION = 0.912
95 PERCENT INTERVAL = 2.743 +/- 0.35

STATION CREEK (CRK) 1 DATE 12-04-70 RECORDER RAMON SHANNON

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
8.90	1.10	8.090	9.00	3.90	2.307	2.50	1.80	1.388
4.70	3.50	1.342	4.70	1.30	3.615	5.00	1.00	5.000
7.00	2.00	3.500	3.60	1.20	3.000	3.60	1.30	2.769
10.00	1.40	7.142	3.60	1.30	2.769	3.50	0.80	4.375
3.60	0.80	4.500	8.50	2.50	3.400	3.00	1.20	2.500
5.30	1.10	4.818	3.30	1.50	2.200	11.50	2.20	5.227
13.00	1.30	10.000	6.50	0.90	7.222	7.00	1.00	7.000
6.30	0.90	7.000	10.60	0.80	13.250	6.10	0.70	8.714
10.40	1.00	10.400	6.60	0.70	9.428	8.70	2.30	3.782
10.00	2.00	5.000	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 5.348
LOG AVE OF RATIOS = 0.65733
STANDARD DEVIATION = 1.769
95 PERCENT INTERVAL = 5.348 +/- 0.65

STATION CREEK (CRK) 2A DATE 12-03-7[illegible] RECORDER GEORGE BARNETT (N7[illegible]W)

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
12.20	2.05	5.951	5.90	1.80	3.277	8.10	1.20	6.750
3.40	1.90	1.789	8.20	1.70	4.823	20.00	4.60	4.347
2.40	0.80	3.000	2.20	0.60	3.666	5.00	1.35	3.703
14.20	3.05	4.655	2.60	1.20	2.166	3.60	0.60	6.000
3.65	1.10	3.318	6.60	0.80	8.250	3.60	1.00	3.600
2.50	0.65	3.846	3.55	1.40	2.535	5.20	1.20	4.333
3.20	0.85	3.764	5.30	1.30	4.076	3.45	0.50	6.900
5.90	1.10	5.363	7.40	1.30	5.692	5.70	1.45	3.931
7.40	1.35	5.481	3.30	0.90	3.666	3.90	1.00	3.900
6.20	2.05	3.024	5.60	1.40	4.000	4.20	0.80	5.250
0.00	0.00	0.000	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 4.368
LOG AVE OF RATIOS = 0.61688
STANDARD DEVIATION = 1.540
95 PERCENT INTERVAL = 4.368 +/- 0.55

STATION CREEK (CRK) 2A DATE 12-03-70 RECORDER RAMON SHANNON (N75W)

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
5.80	1.40	4.142	4.40	1.00	4.400	6.50	1.20	5.416
6.00	1.20	5.000	15.70	3.00	5.233	3.80	1.00	3.800
14.20	4.00	3.550	7.00	2.60	2.692	10.10	3.30	3.060
4.80	1.00	4.800	3.10	0.90	3.444	6.80	1.20	5.666
8.40	1.20	7.000	5.90	2.20	2.681	4.40	1.30	3.384
9.00	3.90	2.307	8.50	1.50	5.666	5.30	1.40	3.785
8.30	1.40	5.928	7.70	1.60	4.812	6.10	1.10	5.545
5.40	1.20	4.500	6.30	1.50	4.199	5.00	1.00	5.000
8.00	1.00	8.000	5.90	0.90	6.555	3.30	1.50	2.200
7.00	1.10	6.363	9.90	2.00	4.950	4.00	0.40	10.000
0.00	0.00	0.000	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 4.802
LOG AVE OF RATIOS = 0.65541
STANDARD DEVIATION = 1.669
95 PERCENT INTERVAL = 4.802 +/- 0.59

STATION CREEK (CRK) 2B DATE 12-03-7C RECORDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
14.20	3.70	3.837	7.00	2.60	2.692	6.75	2.40	2.812
7.70	1.60	4.812	11.80	2.50	4.720	4.25	0.80	5.312
5.50	1.80	3.055	5.25	1.80	2.916	4.40	1.00	4.400
19.10	3.50	5.457	3.00	1.00	3.000	5.00	1.15	4.347
5.60	2.30	2.434	3.00	1.10	2.727	4.10	2.30	1.782
8.40	1.80	4.666	6.70	3.50	1.914	2.50	1.00	2.500
2.40	1.10	2.181	7.00	1.05	6.666	8.40	1.70	4.941
4.95	1.10	4.500	5.50	4.10	1.341	3.60	0.95	3.789
4.10	2.10	1.952	2.20	0.40	5.500	8.50	5.80	1.465
4.50	1.65	2.727	10.70	2.30	4.652	6.80	2.50	2.720
0.00	0.00	0.000	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 3.527
LOG AVE OF RATIOS = 0.51212
STANDARD DEVIATION = 1.250
95 PERCENT INTERVAL = 3.527 +/- 0.44

STATION CREEK (CRK) 2B DATE 12-03-70 RECORDER RAMON SHANNON (N10E)

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
4.50	1.00	4.500	1.90	0.40	4.750	1.80	0.40	4.500
3.30	0.80	4.125	3.50	1.00	3.500	7.00	1.50	4.666
3.50	1.20	2.916	8.70	1.40	6.214	6.10	3.50	1.742
9.60	2.60	3.692	5.30	1.20	4.416	17.50	2.70	6.481
10.60	2.80	3.785	6.30	1.30	4.846	13.00	3.00	4.333
9.20	1.90	4.842	4.00	0.90	4.444	3.20	1.00	3.200
2.70	0.70	3.857	4.20	0.80	5.250	3.50	0.70	5.000
6.70	1.50	4.466	5.60	2.10	2.666	4.90	0.70	7.000
4.20	0.80	5.250	7.40	1.10	6.727	7.60	1.00	7.600
21.30	2.50	8.520	4.60	1.10	4.181	7.10	1.20	5.916
0.00	0.00	0.000	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 4.779
LOG AVE OF RATIOS = 0.65842
STANDARD DEVIATION = 1.669
95 PERCENT INTERVAL = 4.779 +/- 0.59

STATION RUFF SLOPE (RS) 1 DATE 12-03-70 REOCRDER RAMON SHANNON

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
13.00	4.50	2.888	23.50	6.00	3.916	17.50	4.00	4.375
8.70	2.00	4.350	3.60	1.00	3.600	2.00	0.70	2.857
4.50	0.80	5.625	8.50	2.00	4.250	12.00	3.50	3.428
4.30	1.10	3.909	5.20	1.60	3.250	5.30	1.70	3.117
3.60	0.80	4.500	2.30	0.90	2.555	11.50	4.00	2.875
0.00	0.00	0.000	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 3.699
LOG AVE OF RATIOS = 0.55840
STANDARD DEVIATION = 1.367
95 PERCENT INTERVAL = 3.699 +/- 0.69

STATION RUFF SLOPE (RS) 1 DATE 12-03-70 RECORDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
7.50	1.80	4.166	4.30	1.90	2.263	8.00	3.90	2.051
2.80	1.00	2.800	8.50	2.50	3.400	5.90	1.70	3.470
7.50	2.80	2.678	11.20	3.80	2.947	6.20	4.30	1.441
9.70	2.50	3.880	5.50	3.10	1.774	3.50	0.60	5.833
6.40	3.10	2.064	5.40	2.90	1.862	5.20	2.80	1.857
26.70	5.20	5.134	10.30	1.70	6.058	8.60	2.30	3.739
8.60	2.20	3.909	12.00	3.00	4.000	11.40	0.90	12.666
7.00	1.90	3.684	7.70	2.40	3.208	12.20	2.60	4.692
7.50	1.50	5.000	3.40	0.60	5.666	4.80	1.90	2.526
0.00	0.00	0.000	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 3.806
LOG AVE OF RATIOS = 0.52890
STANDARD DEVIATION = 1.325
95 PERCENT INTERVAL = 3.806 +/- 0.50

STATION RUFF SLOPE (RS) 2 DATE 12-03-70 RECORDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
7.10	1.80	3.944	7.80	5.65	1.380	2.45	1.00	2.450
9.20	2.40	3.833	3.90	1.50	2.599	3.00	0.55	5.454
2.50	0.60	4.166	4.20	0.50	8.400	7.80	2.50	3.119
11.80	2.20	5.363	3.70	4.65	0.795	5.20	1.70	3.058
3.90	1.15	3.391	4.85	1.70	2.852	2.80	1.80	1.555
4.30	2.10	2.047	4.80	1.55	3.096	4.00	1.10	3.636
2.90	1.00	2.900	6.50	2.70	2.407	2.80	0.25	11.200
4.80	1.20	4.000	4.60	1.40	3.285	3.10	0.90	3.444
5.85	1.45	4.034	9.00	3.20	2.812	0.00	0.00	0.000
0.00	0.00	0.000	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 3.662
LOG AVE OF RATIOS = 0.50610
STANDARD DEVIATION = 1.268
95 PERCENT INTERVAL = 3.662 +/- 0.48

STATION RUFF SLOPE (RS) 2 DATE 12-03-70 RECORDER RMAON SHANNON

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
4.00	0.90	4.444	3.50	0.70	5.000	4.10	1.20	3.416
3.10	0.80	3.875	4.60	1.20	3.833	4.50	2.10	2.142
5.00	1.00	5.000	4.20	1.50	2.800	4.30	0.80	5.375
6.50	1.20	5.416	3.80	0.80	4.750	2.20	0.60	3.666
4.00	0.80	5.000	3.80	0.70	5.428	5.30	1.90	2.789
5.60	1.70	3.294	5.10	1.90	2.684	2.20	0.90	2.444
6.50	2.00	3.250	6.30	1.50	4.199	2.20	1.10	2.000
7.20	1.30	5.538	4.20	2.00	2.100	10.30	1.50	6.866
6.00	1.50	4.000	4.70	2.20	2.136	2.10	0.70	3.000
5.00	1.50	3.333	11.50	3.00	3.833	8.00	2.00	4.000
0.00	0.00	0.000	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 3.853
LOG AVE OF RATIOS = 0.56347
STANDARD DEVIATION = 1.377
95 PERCENT INTERVAL = 3.853 +/- 0.49

STATION SUM BANK (SB) 1 DATE 12-0[illegible]-70 RECORDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
9.20	3.10	2.967	6.20	1.40	4.428	4.20	1.30	3.230
8.30	1.60	5.187	10.80	1.10	9.818	7.10	0.95	7.473
4.40	1.50	2.933	10.00	2.20	4.545	5.10	1.00	5.100
2.50	2.05	1.219	5.20	1.40	3.714	4.40	0.50	8.800
3.20	0.60	5.333	9.80	0.70	14.000	6.90	2.20	3.136
8.00	2.40	3.333	6.50	1.30	5.000	8.00	1.50	5.333
10.50	2.40	4.375	3.20	0.50	6.400	3.70	0.70	5.285
8.60	2.30	3.739	3.80	0.80	4.750	0.00	0.00	0.000
0.00	0.00	0.000	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 5.221
LOG AVE OF RATIOS = 0.66867
STANDARD DEVIATION = 1.771
95 PERCENT INTERVAL = 5.221 +/- 0.72

STATION SUM BANK (SB) 1 DATE 12-03-70 RECORDER RAMON SHANNON

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
5.20	2.00	2.600	3.70	0.80	4.625	3.60	0.50	7.200
12.00	2.00	6.000	6.20	1.40	4.428	12.90	3.00	4.300
6.20	2.10	2.952	4.50	1.00	4.500	4.90	2.00	2.450
4.90	2.00	2.450	4.00	0.80	5.000	3.30	0.90	3.666
8.20	1.40	5.857	4.60	1.20	3.833	3.60	1.40	2.571
3.60	0.70	5.142	5.50	1.00	5.500	6.20	1.20	5.166
3.10	0.70	4.428	4.40	1.40	3.142	3.30	0.10	33.000
14.00	3.80	3.684	13.10	1.50	8.733	6.70	1.40	4.785
7.60	1.80	4.222	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 5.609
LOG AVE OF RATIOS = 0.66245
STANDARD DEVIATION = 1.833
95 PERCENT INTERVAL = 5.609 +/- 0.71

STATION SUM BANK (SB) 2 DATE 12-0[illegible]-70 RECORDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
26.40	8.10	3.259	10.70	0.90	11.888	12.70	3.50	3.628
13.20	4.10	3.219	13.20	1.60	8.250	6.00	1.10	5.454
4.80	1.10	4.363	2.65	1.10	2.409	4.30	0.90	4.777
4.50	0.95	4.736	3.40	0.70	4.857	4.30	1.50	2.866
9.90	2.00	4.950	3.80	1.20	3.166	6.60	4.20	1.571
9.70	3.70	2.621	4.50	1.50	3.000	11.80	3.10	3.806
7.20	2.80	2.571	5.40	1.60	3.375	0.00	0.00	0.000
0.00	0.00	0.000	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 4.238
LOG AVE OF RATIOS = 0.58176
STANDARD DEVIATION = 1.483
95 PERCENT INTERVAL = 4.238 +/- 0.65

STATION SUM BANK (SB) 2 DATE 12-03-70 RECORDER RAMON SHANNON

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
7.90	2.50	3.160	10.00	2.10	4.761	9.50	4.50	2.111
6.00	2.40	2.500	4.10	0.70	5.857	8.50	1.10	7.727
12.00	3.00	4.000	6.50	2.00	3.250	8.50	2.50	3.400
5.70	1.60	3.562	3.90	1.10	3.545	4.30	2.40	1.791
4.00	1.40	2.857	3.60	1.50	2.400	7.80	1.50	5.199
4.70	1.20	3.916	9.50	1.80	5.277	3.60	1.50	2.400
7.60	1.90	4.000	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 3.774
LOG AVE OF RATIOS = 0.54765
STANDARD DEVIATION = 1.356
95 PERCENT INTERVAL = 3.774 +/- 0.60

STATION TANK (TK) 1 DATE 12-04-70 RECORDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
8.80	3.80	2.315	4.80	3.50	1.371	1.70	1.20	1.416
2.00	1.70	1.176	1.80	0.90	2.000	6.80	3.20	2.125
4.60	2.40	1.916	2.20	2.00	1.100	2.60	1.80	1.444
4.70	1.70	2.764	3.60	3.30	1.090	4.40	2.60	1.692
2.50	0.90	2.777	7.90	4.10	1.926	3.65	4.00	0.912
2.30	1.10	2.090	4.70	1.70	2.764	2.90	1.35	2.148
4.45	1.80	2.472	7.00	3.20	2.187	0.00	0.00	0.000
0.00	0.00	0.000	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 1.884
LOG AVE OF RATIOS = 0.25297
STANDARD DEVIATION = 0.642
95 PERCENT INTERVAL = 1.884 +/- 0.28

STATION TANK (TK) 1 DATE 12-04-70 RECORDER RAMON SHANNON

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
6.90	4.10	1.682	4.50	1.60	2.812	8.30	2.70	3.074
7.50	1.10	6.818	3.00	1.50	2.000	2.20	0.70	3.142
5.30	3.00	1.766	4.00	2.40	1.666	5.10	2.20	2.318
3.20	0.80	4.000	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 2.928
LOG AVE OF RATIOS = 0.42310
STANDARD DEVIATION = 1.067
95 PERCENT INTERVAL = 2.928 +/- 0.66

STATION TANK (TK) 2 DATE 12-04-70 RECORDER RAMON SHANNON

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
9.50	0.70	13.571	18.00	4.00	4.500	9.40	2.00	4.700
10.20	3.50	2.914	10.50	7.90	1.329	4.60	1.70	2.705
1.50	1.50	1.000	5.80	1.50	3.866	4.60	2.00	2.300
3.90	1.10	3.545	4.80	1.00	4.800	9.30	1.40	6.642
10.00	5.50	1.818	3.10	1.20	2.583	2.60	1.10	2.363
8.00	1.80	4.444	3.00	2.00	1.500	8.30	1.00	8.300
8.60	2.50	3.440	10.20	3.00	3.400	3.60	2.10	1.714
10.50	3.50	3.000	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 3.838
LOG AVE OF RATIOS = 0.50219
STANDARD DEVIATION = 1.298
95 PERCENT INTERVAL = 3.838 +/- 0.54

STATION TANK (TK) 2 DATE 12-04-70 RECORDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
4.30	2.20	1.954	8.65	4.70	1.840	12.30	3.00	4.100
4.70	1.10	4.272	2.10	1.05	2.000	3.20	1.40	2.285
47.10	12.70	3.708	8.60	2.50	3.440	8.00	4.10	1.951
4.30	2.30	1.869	5.90	2.80	2.107	14.60	4.50	3.244
5.60	2.90	1.931	3.30	1.70	1.941	20.20	9.00	2.244
9.10	4.00	2.275	9.70	5.30	1.830	8.30	3.60	2.305
10.40	3.20	3.250	11.20	1.10	10.181	6.60	1.30	5.076
7.40	2.10	3.523	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 3.060
LOG AVE OF RATIOS = 0.43825
STANDARD DEVIATION = 1.080
95 PERCENT INTERVAL = 3.060 +/- 0.45

STATION-POWER LINE (PL) 1 DATE 12-03-70 RECORDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
8.40	1.90	4.421	2.50	0.30	8.333	0.90	0.20	4.500
5.50	1.50	3.666	4.00	0.90	4.444	9.60	3.30	2.909
3.80	1.60	2.375	5.10	2.00	2.550	1.90	0.60	3.166
10.50	3.30	3.181	5.00	1.60	3.125	2.20	1.30	1.692
7.10	1.80	3.944	2.00	1.20	1.666	4.40	2.30	1.913
2.60	1.10	2.363	1.20	0.90	1.333	7.10	3.25	2.184
4.80	2.20	2.181	4.80	0.60	8.000	2.20	0.30	7.333
5.30	2.30	2.304	3.50	1.00	3.500	5.50	1.35	4.074
1.80	0.20	9.000	1.50	1.00	1.500	5.50	2.00	2.750
1.50	0.30	5.000	3.20	1.40	2.285	1.70	1.20	1.416
4.90	1.75	2.800	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 3.545
LOG AVE OF RATIOS = 0.49004
STANDARD DEVIATION = 1.223
95 PERCENT INTERVAL = 3.545 +/- 0.43

STATION POWER LINE (PL) 2 DATE 12-04-70 RECORDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
3.90	1.00	3.900	14.00	1.10	12.727	13.50	4.00	3.375
4.20	1.50	2.800	5.50	2.00	2.750	2.50	0.60	4.166
16.10	0.20	80.500	7.20	2.20	3.272	2.80	1.40	2.000
6.10	2.10	2.904	12.10	4.85	2.494	7.50	1.90	3.947
2.00	0.40	5.000	2.20	0.50	4.400	3.20	0.70	4.571
3.50	1.90	1.842	4.40	0.90	4.888	4.90	1.00	4.900
28.50	2.60	10.961	3.50	1.00	3.500	38.00	7.60	5.000
5.50	2.10	2.619	3.80	0.80	4.750	20.50	4.20	4.880
10.70	4.90	2.183	7.80	1.80	4.333	6.20	2.00	3.100
9.15	1.50	6.100	8.20	4.00	2.050	9.20	2.70	3.407
4.60	1.10	4.181	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 6.693
LOG AVE OF RATIOS = 0.62387
STANDARD DEVIATION = 1.954
95 PERCENT INTERVAL = 6.693 +/- 0.68

STATION DEVIL'S CAN. EAST DCE 1A DATE 12-06-70 RECORDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
3.05	0.50	6.100	3.80	2.40	1.583	4.30	4.40	0.977
5.10	1.15	4.434	2.30	1.00	2.300	3.10	2.10	1.476
4.50	1.30	3.461	1.20	1.05	1.142	2.30	0.60	3.833
5.30	3.90	1.358	2.75	1.35	2.037	3.20	3.10	1.032
4.55	0.80	5.687	17.30	3.85	4.493	10.70	2.80	3.821
2.00	1.40	1.428	3.20	1.90	1.684	3.35	1.20	2.791
1.35	1.20	1.125	5.50	0.90	6.111	4.80	2.20	2.181
9.20	3.50	2.628	3.15	3.30	0.954	5.60	3.15	1.777
12.50	1.90	6.578	6.50	1.20	5.416	4.60	2.10	2.190
9.40	2.05	4.585	3.50	1.70	2.058	2.15	1.00	2.150
0.00	0.00	0.000	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 2.913
LOG AVE OF RATIOS = 0.38772
STANDARD DEVIATION = 0.971
95 PERCENT INTERVAL = 2.913 +/- 0.34

STATION DEVIL'S CAN. EAST DCE 1B DATE 12-06-70 RECORDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
4.00	1.90	2.105	6.70	0.70	9.571	2.70	2.40	1.125
4.30	1.20	3.583	8.20	4.15	1.975	4.60	1.20	3.833
2.40	1.15	2.086	6.10	2.40	2.541	2.25	1.90	1.184
8.70	4.00	2.175	3.00	2.45	1.224	5.00	1.50	3.333
2.10	0.80	2.625	2.10	0.50	4.200	13.40	3.80	3.526
9.50	1.60	5.937	3.50	1.65	2.121	8.10	1.60	5.062
4.70	1.80	2.611	6.20	2.20	2.818	6.90	1.50	4.600
4.40	2.10	2.095	8.30	3.20	2.593	5.50	1.60	3.437
7.90	2.90	2.724	5.00	2.05	2.439	3.80	1.35	2.814
4.10	1.50	2.733	4.00	1.65	2.424	5.30	2.20	2.409
1.50	1.25	1.200	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 3.003
LOG AVE OF RATIOS = 0.42854
STANDARD DEVIATION = 1.048
95 PERCENT INTERVAL = 3.003 +/- 0.36

STATION DEVIL'S CAN. EAST DCE 1C DATE 12-06-70 RECORDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
11.00	5.60	1.964	4.65	1.30	3.576	3.00	2.70	1.111
5.90	4.00	1.475	2.20	1.90	1.157	9.70	2.15	4.511
14.20	7.20	1.972	13.50	3.65	3.698	2.75	0.80	3.437
3.00	0.80	3.750	1.90	2.20	0.863	7.60	1.70	4.470
1.60	0.60	2.666	6.80	3.50	1.942	3.70	1.80	2.055
9.40	2.30	4.086	6.60	1.55	4.258	6.10	1.80	3.388
5.00	0.90	5.555	6.90	3.10	2.225	3.20	2.00	1.600
5.90	3.90	1.512	4.40	3.80	1.157	11.80	6.80	1.735
1.50	1.55	0.967	6.50	2.10	3.095	14.00	2.10	6.666
13.00	8.10	1.604	6.60	4.00	1.650	8.80	3.20	2.750
4.60	1.00	4.600	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 2.758
LOG AVE OF RATIOS = 0.37876
STANDARD DEVIATION = 0.934
95 PERCENT INTERVAL = 2.758 +/- 0.32

STATION DEVIL'S CAN. EAST DCE 2C DATE 12-06-70 RECORDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
9.20	4.50	2.044	3.00	1.40	2.142	3.20	1.60	2.000
2.90	1.30	2.230	10.80	2.10	5.142	5.90	2.00	2.950
8.50	2.60	3.269	8.80	2.80	3.142	7.50	1.60	4.687
6.90	1.50	4.600	6.10	1.70	3.588	1.65	0.90	1.833
2.60	1.15	2.260	4.10	2.60	1.576	7.10	2.15	3.302
7.50	3.40	2.205	5.90	2.80	2.107	7.50	2.00	3.750
3.60	2.20	1.636	9.80	2.90	3.379	2.00	1.15	1.739
1.80	0.55	3.272	7.00	2.30	3.043	5.80	1.80	3.222
10.80	1.80	6.000	2.30	3.10	0.741	2.80	1.40	2.000
7.00	1.80	3.888	26.50	6.40	4.140	3.10	2.40	1.291
3.50	1.50	2.333	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 2.887
LOG AVE OF RATIOS = 0.42170
STANDARD DEVIATION = 1.018
95 PERCENT INTERVAL = 2.887 +/- 0.35

STATION DEVIL'S CAN. EAST DCE 2B DATE 12-06-70 RECORDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
4.50	3.20	1.406	13.10	1.50	8.733	3.90	2.00	1.950
2.60	0.90	2.888	6.00	2.21	2.714	6.80	1.90	3.578
4.10	1.40	2.928	2.30	1.80	1.277	10.50	3.80	2.763
5.00	1.20	4.166	6.80	1.00	6.800	6.00	3.45	1.739
3.50	1.90	1.842	7.10	1.50	4.733	1.70	1.60	1.062
7.60	2.70	2.814	5.40	1.00	5.400	8.80	2.90	3.034
2.70	1.10	2.454	3.20	0.60	5.333	2.60	0.70	3.714
5.00	3.00	1.666	3.55	0.70	5.071	2.30	1.50	1.533
2.80	0.70	4.000	1.20	0.90	1.333	3.60	1.20	3.000
4.80	1.70	2.823	1.45	1.20	1.208	2.35	0.90	2.611
1.80	2.00	0.900	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 3.080
LOG AVE OF RATIOS = 0.42170
STANDARD DEVIATION = 1.047
95 PERCENT INTERVAL = 3.080 +/- 0.36

STATION DEVIL'S CAN. EAST DCE 2A DATE 12-06-70 RECORDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
6.00	2.10	2.857	11.30	3.70	3.054	5.90	1.00	5.900
2.50	2.40	1.041	1.50	1.20	1.250	5.15	2.10	2.452
14.20	6.20	2.290	3.10	1.10	2.818	9.80	4.20	2.333
3.60	1.60	2.250	17.20	4.00	4.300	4.30	1.60	2.687
6.90	2.60	2.653	3.10	3.00	1.033	6.20	1.65	3.757
10.10	3.80	2.657	11.20	3.70	3.027	5.00	1.00	5.000
3.35	0.60	5.583	7.00	2.80	2.500	2.75	0.65	4.230
2.20	0.70	3.142	4.00	2.20	1.818	3.90	1.20	3.250
3.70	1.50	2.466	4.20	1.10	3.818	5.70	1.30	4.384
4.70	1.00	4.700	3.25	1.25	2.600	6.30	1.50	4.199
3.75	0.90	4.166	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 3.168
LOG AVE OF RATIOS = 0.46491
STANDARD DEVIATION = 1.123
95 PERCENT INTERVAL = 3.168 +/- 0.39

STATION DEVIL'S CAN. EAST DCE 3 DATE 12-06-70

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
26.10	11.00	2.372	8.60	3.00	2.866	7.70	1.50	5.133
6.80	1.60	4.250	5.40	1.00	5.400	3.00	1.35	2.222
3.10	1.50	2.066	6.90	1.70	4.058	6.80	3.00	2.266
4.60	1.08	4.259	20.00	7.00	2.857	8.00	5.10	1.568
8.80	1.70	5.176	8.50	2.70	3.148	4.70	1.05	4.476
7.60	2.50	3.040	4.20	1.40	3.000	4.60	2.50	1.840
3.40	0.90	3.777	4.60	1.50	3.066	3.55	1.50	2.366
5.10	3.50	1.457	5.70	2.70	2.111	3.60	1.50	2.400
6.50	2.10	3.095	4.50	2.00	2.250	3.70	1.10	3.363
3.20	0.80	4.000	1.40	1.70	0.823	2.60	0.90	2.888
6.70	2.60	2.576	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 3.038
LOG AVE OF RATIOS = 0.45044
STANDARD DEVIATION = 1.082
95 PERCENT INTERVAL = 3.038 +/- 0.38

STATION DEVIL'S CAN. EAST DCE 4 DATE 12-06-70 RECORDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
3.20	1.30	2.461	7.20	3.30	2.181	6.20	1.90	3.263
7.70	2.40	3.208	7.10	3.10	2.290	13.70	3.90	3.512
3.50	3.00	1.166	4.00	3.30	1.212	4.40	4.50	0.977
2.30	1.50	1.533	6.10	2.00	3.050	4.00	0.95	4.210
10.30	4.00	2.575	5.00	1.10	4.545	5.00	0.10	50.000
2.00	0.90	2.222	3.50	1.20	2.916	12.20	7.80	1.564
4.75	2.10	2.261	5.00	1.60	3.125	2.20	1.10	2.000
5.30	1.00	5.300	6.60	1.80	3.666	3.30	1.10	3.000
5.50	1.60	3.437	14.20	5.60	2.535	4.50	2.00	2.250
9.00	2.00	4.500	4.00	1.10	3.636	3.00	1.30	2.307
4.40	1.40	3.142	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 4.324
LOG AVE OF RATIOS = 0.45634
STANDARD DEVIATION = 1.319
95 PERCENT INTERVAL = 4.324 +/- 0.46

STATION DEVIL'S CAN. EAST DCE 5 DATE 12-06-70 RECORDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
8.40	2.60	3.230	2.30	2.30	1.000	7.40	3.10	2.387
3.80	1.80	2.111	10.00	1.10	9.090	5.10	1.70	3.000
10.80	3.80	2.842	6.30	1.90	3.315	3.20	1.00	3.200
1.60	0.80	2.000	5.10	1.60	3.187	12.00	2.00	6.000
11.90	2.20	5.409	10.80	2.60	4.153	8.80	2.00	4.400
2.50	0.80	3.125	4.20	3.60	1.166	5.00	1.30	3.846
5.20	2.80	1.857	1.70	0.20	8.500	3.20	0.70	4.571
4.20	2.00	2.100	2.80	2.20	1.272	8.00	2.50	3.200
1.90	1.50	1.266	8.10	1.40	5.785	2.95	1.50	1.966
2.70	0.60	4.500	3.00	2.10	1.428	1.00	0.90	1.111
1.10	0.90	1.222	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 3.298
LOG AVE OF RATIOS = 0.44327
STANDARD DEVIATION = 1.113
95 PERCENT INTERVAL = 3.298 +/- 0.39

TAB

Appendix C

ASARCO DACITE DATA

Combined Readings - Ratios
Uncorrected Data

George S. Barnett April 20, 1971

ASARCO DACITE DATA SH-1 SAMPLES TAKEN 11/12/70 BY RAMON SHANNON

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
1.50	0.50	3.000	3.20	0.70	4.571	1.90	0.40	4.750
2.60	0.70	3.714	4.50	0.80	5.625	6.00	1.00	6.000
2.60	0.40	6.500	2.40	0.40	6.000	1.50	0.50	3.000
4.50	1.70	2.647	2.20	0.40	5.500	2.80	1.00	2.800
1.40	0.40	3.500	1.80	0.40	4.500	14.25	2.20	6.477
2.20	0.50	4.400	6.20	1.00	6.200	5.50	1.70	3.235
1.10	0.20	5.500	3.40	0.50	6.800	5.90	0.50	11.800
5.80	1.10	5.272	3.70	0.50	7.400	10.00	0.80	12.500
10.80	1.80	6.000	6.20	3.20	1.937	6.00	0.85	7.058
15.80	2.40	6.583	3.90	0.60	6.500	5.70	1.50	3.800
6.40	1.70	3.764	3.00	1.60	1.875	5.00	1.10	4.545
3.30	1.50	2.200	8.40	1.50	5.600	7.20	2.00	3.600
11.35	3.70	3.067	7.30	2.00	3.650	11.70	3.80	3.078
15.40	2.60	5.923	8.30	1.40	5.928	12.10	1.90	6.368
5.80	2.30	2.521	4.00	0.50	8.000	0.00	0.00	0.000
0.00	0.00	0.000	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 5.084 6.81 100' E DUMP
LOG AVE OF RATIOS = 0.66699
STANDARD DEVIATION = 1.726
95 PERCENT INTERVAL = 5.084 +/- 0.51

STATION SHAFT SH2 DATE 11-12-70 RECORDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
3.50	0.80	4.375	3.30	1.20	2.750	9.00	1.50	6.000
9.50	2.60	3.653	4.20	1.10	3.818	5.30	1.60	3.312
3.40	1.20	2.833	10.50	3.10	3.387	5.00	0.70	7.142
4.00	1.00	4.000	9.00	1.10	8.181	2.70	1.10	2.454
4.70	1.20	3.916	1.70	0.70	2.428	7.20	1.40	5.142
2.80	1.10	2.545	3.50	0.85	4.117	6.00	2.20	2.727
6.20	1.10	5.636	4.60	1.90	2.421	2.70	0.35	7.714
3.50	0.80	4.375	4.40	1.20	3.666	2.50	0.45	5.555
3.20	1.00	3.200	3.40	0.70	4.857	2.50	0.35	7.142
6.10	1.50	4.066	6.20	0.70	8.857	3.20	1.10	2.909
4 2.50	0.40	6.250	~~>2.50~~	~~0.40~~	~~6.250~~	4.00	0.50	8.000
3.30	0.80	4.125	5.00	0.80	6.250	3.40	1.10	3.090
5.60	2.00	2.800	3.20	0.90	3.555	4.00	1.70	2.352
2.90	0.60	4.833	2.50	0.70	3.571	3.10	0.50	6.200
4.80	1.50	3.200	3.40	0.40	8.500	~~>43.50~~	~~0.70~~	~~62.142~~ 4.50 0.7
~~>43.10~~ 4.10	~~0.80~~ 0.90	~~53.875~~	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 6.917 6.91 ≡ DWP
LOG AVE OF RATIOS = 0.67830
STANDARD DEVIATION = 2.059
95 PERCENT INTERVAL = 6.917 +/- 0.59

STATION SHAFT SH 3 DATE 11-12-70 RECORDER RAMON SHANNON

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
3.70	0.70	5.285	2.30	0.60	3.833	4.70	0.40	11.750
1.80	0.70	2.571	3.30	0.80	4.125	1.70	0.60	2.833
3.00	0.60	5.000	2.30	0.40	5.750	2.70	0.70	3.857
3.30	0.40	8.250	3.00	0.70	4.285	4.20	0.80	5.250
3.40	0.70	4.857	2.90	0.60	4.833	3.30	0.70	4.714
2.70	0.60	4.500	1.40	0.20	7.000	2.70	0.60	4.500
1.20	0.30	4.000	2.00	0.40	5.000	3.70	1.30	2.846
2.10	0.30	7.000	1.50	0.60	2.500	4.00	0.60	6.666
2.60	0.60	4.333	9.70	1.30	7.461	*****	1.40	71.928
>60.80	1.50	40.533	>40.00	0.60	66.666	>90.50	1.50	60.333
>90.20	0.95	94.947	3.00	0.60	5.000	5.50	1.20	4.583
4.20	0.25	16.800	5.40	1.70	3.176	5.10	1.15	4.434
8.50	0.95	8.947	3.20	1.10	2.909	7.10	1.20	5.916
3.00	0.80	3.750	3.00	1.00	3.000	5.50	0.50	11.000
4.10	1.00	4.100	12.15	3.10	3.919	4.30	0.50	8.600
15.00	2.70	5.555	2.80	4.50	0.622	4.90	1.00	4.900
3.40	1.10	3.090	2.50	0.40	6.250	4.70	1.65	2.848
7.60	1.80	4.222	5.50	0.60	9.166	2.40	0.90	2.666
0.00	0.00	0.000	0.00	0.00	0.000	0.00	0.00	0.000

10.70 1.4

ARITH. AVE OF RATIOS = 10.979 10.57 ≡ DWP
LOG AVE OF RATIOS = 0.77555
STANDARD DEVIATION = 2.811
95 PERCENT INTERVAL = 10.979 +/- 0.74

STATION SUTTON'S SUMMIT SS 1 DATE 11-24-70 RECORDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

	A	B	C	A	B	C	A	B	C
7	6.60	1.20	5.500	13.60	1.75	7.771	2.50	0.80	3.125
	7.50	2.20	3.409	>6.00	1.70	3.529	2.20	0.60	3.666
	2.10	0.70	3.000	1.40	0.40	3.500	3.40	0.60	5.666
	4.00	0.70	5.714	35.00	6.60	5.303	21.10	4.30	4.906
	16.70	3.70	4.513	7.80	2.10	3.714	3.50	0.80	4.375
	6.10	1.00	6.100	2.90	2.90	1.000	3.20	3.40	0.941
	9.00	5.20	1.730	3.40	3.25	1.046	3.40	1.40	2.428
	2.20	0.70	3.142	3.60	1.40	2.571	3.40	1.30	2.615
	2.40	1.30	1.846	1.70	0.40	4.250	5.00	2.80	1.785
	2.70	0.30	9.000	5.90	1.90	3.105	2.10	1.70	1.235
	0.00	0.00	0.000	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 3.683
LOG AVE OF RATIOS = 0.49980
STANDARD DEVIATION = 1.256
95 PERCENT INTERVAL = 3.683 +/- 0.44

ratio
2.48 ≈ 100' E DWP

STATION-SUTTON'S SUMMIT (SS) 2 DATE 11-24-70 RECORDER RAMON SHANNON

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
8.50	3.40	2.500	4.00	1.10	3.636	4.80	1.40	3.428
6.00	1.10	5.454	2.20	0.90	2.444	2.60	0.80	3.250
3.50	1.30	2.692	5.00	1.80	2.777	3.70	1.00	3.700
6.00	1.90	3.157	11.50	4.00	2.875	6.60	2.20	3.000
4.90	1.10	4.454	1.80	0.50	3.600	3.40	0.60	5.666
7.00	1.50	4.666	6.00	1.00	6.000	2.10	0.60	3.500
8.00	2.00	4.000	4.70	0.80	5.875	3.50	0.40	8.750
13.50	2.40	5.625	9.50	2.00	4.750	5.00	1.00	5.000
2.50	0.50	5.000	7.40	1.20	6.166	~~7.30~~	~~1.60~~	~~4.562~~
5.50	1.20	4.583	~~7.50~~	~~1.50~~	~~5.000~~	6.30	2.00	3.150
0.00	0.00	0.000	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 4.308 2.48 ≡ DWP
LOG AVE OF RATIOS = 0.61342
STANDARD DEVIATION = 1.525
95 PERCENT INTERVAL = 4.308 +/- 0.54

STATION-SUTTON'S SUMMIT (SS) 3 DATE 11-24-70 RECORDER RAMON SHANNON

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
14.00	3.00	4.666	8.50	2.00	4.250	3.80	1.40	2.714
9.00	2.50	3.600	4.90	1.00	4.900	5.20	0.70	7.428
1.20	0.50	2.400	8.00	2.50	3.200	3.40	1.20	2.833
7.80	1.80	4.333	8.00	1.50	5.333	3.70	0.80	4.625
12.00	1.60	7.500	4.70	0.60	7.833	6.00	0.70	8.571
6.50	0.60	10.833	5.10	3.00	1.700	8.00	1.00	8.000
5.40	2.00	2.700	5.50	2.00	2.750	3.00	0.80	3.750
7.70	1.50	5.133	5.80	1.60	3.625	3.50	1.70	2.058
14.50	2.40	6.041	10.70	1.20	8.916	8.40	0.25	33.600
5.10	1.40	3.642	7.80	2.20	3.545	3.80	1.00	3.800
12.00	3.40	3.529	4.50	1.80	2.500	6.30	1.40	4.500
3.80	0.25	15.200	2.80	0.20	14.000	4.00	0.80	5.000
3.50	0.55	6.363	2.50	0.30	8.333	4.70	0.55	8.545
9.40	1.75	5.371	7.80	1.40	5.571	2.15	0.50	4.300
5.00	1.10	4.545	7.20	1.00	7.200	3.50	0.23	15.217
5.00	0.55	9.090	6.80	1.10	6.181	2.25	0.50	4.500
4.20	0.55	7.636	2.40	0.50	4.800	1.80	0.45	4.000
8.00	2.30	3.478	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 6.233
LOG AVE OF RATIOS = 0.71656
STANDARD DEVIATION = 1.992
95 PERCENT INTERVAL = 6.233 +/- 0.54

5.74 = D

STATION JI RANCH JI 1 DATE 11-24-70 RECORDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

	A	B	C	A	B	C	A	B	C
11	9.00	1.20	7.500	5.00	2.80	1.785	3.00	1.05	2.857
	4.30	1.00	4.300	2.00	0.70	2.857	13.00	4.20	3.095
	6.10	3.00	2.033	2.50	1.30	1.923	9.10	3.60	2.527
	11.85	5.30	2.235	5.60	4.50	1.244	3.30	3.00	1.100
	3.70	2.90	1.275	6.55	1.80	3.638	9.10	1.10	8.272
	11.30	3.80	2.973	3.50	0.80	4.375	7.70	2.40	3.208
	3.90	1.00	3.900	12 5.30	1.10	4.818	22.00	6.00	3.666
	1.70	0.30	5.666	7.00	1.50	4.666	6.50	3.50	1.857
	4.50	1.20	3.750	2.30	0.70	3.285	5.40	0.90	6.000
	4.60	0.70	6.571	7.50	0.60	12.500	3.70	0.80	4.625
	6.00	1.50	4.000	7.00	0.10	70.000	1.80	1.30	1.384
	4.80	1.20	4.000	8.80	1.30	6.769	2.50	1.70	1.470
	1.70	0.80	2.125	4.50	1.00	4.500	6.30	1.80	3.500
	2.80	0.50	5.600	4.10	0.90	4.555	4.90	0.40	12.250
	4.90	1.10	4.454	4.50	0.90	5.000	0.00	0.00	0.000
	0.00	0.00	0.000	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 5.639 2.56 = DWF
LOG AVE OF RATIOS = 0.57686
STANDARD DEVIATION = 1.699
95 PERCENT INTERVAL = 5.639 +/- 0.50

STATION-JJ RANCH (JJ) 2 DATE 11-24-70 RECORDER-RAMON SHANNON

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

	A	B	C	A	B	C	A	B	C
13	7.30	2.30	3.173	8.00	3.00	2.666	7.40	0.70	10.571
	14.00	5.00	2.800	17.10	3.50	4.885	16.50	8.80	1.875
	10.60	4.10	2.585	7.20	2.00	3.600	9.30	3.40	2.735
	17.50	4.60	3.804	8.90	1.30	6.846	7.10	0.80	8.875
	10.70	1.50	7.133	12.20	2.70	4.518	8.20	0.85	9.647
	20.80	3.20	6.500	18.20	4.50	4.044	13.20	5.10	2.588
	15.30	2.00	7.650	7.90	2.40	3.291	4.70	2.10	2.238
	4.40	0.80	5.500	2.20	0.80	2.750	11.70	3.90	3.000
	9.50	3.50	2.714	>2.10	~~1.00~~	2.100 / 1.05	6.90	1.10	6.272
	6.30	2.60	2.423	7.20	1.80	4.000 14	11.60	7.00	1.657
	8.00	1.00	8.000	4.20	0.70	6.000	16.20	7.50	2.160
	2.70	0.50	5.400	15.10	6.50	2.323	10.00	4.00	2.500
	17.00	3.20	5.312	14.40	4.10	3.512	17.80	3.20	5.562
	0.00	0.00	0.000	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 4.441 3.96 = DWF
LOG AVE OF RATIOS = 0.59361
STANDARD DEVIATION = 1.515
95 PERCENT INTERVAL = 4.441 +/- 0.47

STATION OAK FLAT (OF) 1 DATE 11-25-70 REOCRDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

	A	B	C	A	B	C	A	B	C
15	3.40	0.60	5.666	2.50	1.15	2.173	9.20	3.30	2.787
	2.50	1.00	2.500	2.90	1.10	2.636	2.20	2.10	1.047
	10.50	6.10	1.721	11.50	7.20	1.597	13.80	4.80	2.875
	17.10	9.80	1.744	13.10	3.60	3.638	11.90	3.90	3.051
	14.40	3.60	4.000	10.30	5.80	1.775	7.20	3.20	2.250
	12.90	6.40	2.015	8.50	5.00	1.700	6.00	4.40	1.363
	9.00	5.10	1.764	26.20	9.60	2.729	4.15	3.80	1.092
	4.60	4.00	1.150	4.00	4.10	0.975	4.40	2.60	1.692
	>3.20	~~3.50~~	0.914	13.30	7.20	1.847	7.20	3.80	1.894
	3.50	2.90	1.206	2.40	1.80	1.333	0.00	0.00	0.000
	0.00	0.00	0.000	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 2.108 ≈ 100' N 2.54 DW
LOG AVE OF RATIOS = 0.28084
STANDARD DEVIATION = 0.703
95 PERCENT INTERVAL = 2.108 +/- 0.25

STATION OAK FLAT (OF) 2 DATE 11-25-70 RECORDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

	A	B	C	A	B	C	A	B	C	
16	6.80	2.20	3.090	~~6.80~~	~~2.20~~	~~3.090~~	1.90	0.75	2.533	
	3.50	1.10	3.181	3.50	1.00	3.500	1.50	0.80	1.875	
	2.60	1.45	1.793	>6.20	25.00	0.248	>3.90	~~23.00~~	0.169	2.30
	>6.70	~~25.00~~	0.268	>3.00	29.00	0.103	5.60	2.90	1.931	
	1.70	2.30	0.739	4.30	1.50	2.866	2.30	1.10	2.090	
	8.35	2.80	2.982	4.30	4.00	1.075	4.00	1.25	3.200	
	3.70	0.90	4.111	8.00	4.50	1.777	> ~~4.30~~	~~2.30~~	~~1.869~~	4.20 4.2
	2.50	1.10	2.272	3.50	1.70	2.058	7.10	2.10	3.380	
	6.50	3.30	1.969	9.50	2.80	3.392	4.70	1.70	2.764	
	4.50	3.60	1.250	5.80	2.60	2.230	0.00	0.00	0.000	
	0.00	0.00	0.000	0.00	0.00	0.000	0.00	0.00	0.000	

ARITH. AVE OF RATIOS = 2.131 ≈ 1000' D 2.54 (H
LOG AVE OF RATIOS = 0.20737 EFI
STANDARD DEVIATION = 0.486 fault
95 PERCENT INTERVAL = 2.131 +/- 0.17

STATION OAK FLAT (OF) 3 DATE 11-25-70 RECORDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

	A	B	C	A	B	C	A	B	C
17	7.50	1.90	3.947	8.10	1.25	6.480	7.50	3.20	2.343
	5.55	1.75	3.171	3.70	2.00	1.850	3.40	1.35	2.518
	3.50	1.20	2.916	8.30	3.00	2.766	4.20	2.30	1.826
	6.00	2.80	2.142	3.60	1.40	2.571	4.55	1.80	2.527
	9.30	3.70	2.513	3.10	1.30	2.384	4.00	1.85	2.162
	3.50	1.20	2.916	3.20	1.20	2.666	1.30	1.55	0.838
	4.30	2.20	1.954	2.40	1.15	2.086	3.10	1.10	2.818
	8.10	3.80	2.131	2.70	1.40	1.928	2.00	2.10	0.952
	4.10	2.20	1.863	3.30	1.60	2.062	11.20	4.70	2.382
	0.00	0.00	0.000	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 2.471 ≈ 200/N = 4.69 pwi should be
LOG AVE OF RATIOS = 0.36302
STANDARD DEVIATION = 0.876
95 PERCENT INTERVAL = 2.471 +/- 0.33

STATION THROW NO. (235) 1 DATE 11-25-70 RECORDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

	A	B	C	A	B	C	A	B	C	
12	12.20	7.60	1.605	11.20	4.60	2.434	>6.00	~~6.00~~	0.230	
	12.90	7.40	1.743	5.20	1.50	3.466	3.10	0.70	4.428	
	14.40	5.50	2.618	8.40	4.70	1.787	6.10	1.50	4.066	
	1.90	0.80	2.375	6.80	2.90	2.344	10.60	3.80	2.789	
	2.90	2.10	1.380	8.70	3.50	2.485	8.60	2.70	3.185	
	2.50	2.20	1.136	4.30	1.90	2.263	4.50	0.90	5.000	
	6.80	2.50	2.720	3.30	0.90	3.666	7.70	2.60	2.961	
	10.70	6.10	1.754	8.90	5.70	1.561	9.90	4.00	2.475	
	4.70	2.00	2.350	3.50	2.10	1.666	7.60	3.00	2.533	
	0.00	0.00	0.000	0.00	0.00	0.000	0.00	0.00	0.000	

ARITH. AVE OF RATIOS = 2.482 ≈ Sta. 2.59 DWP
LOG AVE OF RATIOS = 0.34442
STANDARD DEVIATION = 0.838
95 PERCENT INTERVAL = 2.482 +/- 0.31

STATION THROW NO. (235) 2 DATE 11-25-70 RECORDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

	A	B	C	A	B	C	A	B	C
	4.20	1.00	4.200	5.00	2.15	2.325	2.80	1.05	2.666
19	18.60	11.30	1.646	12.30	5.20	2.365	12.40	5.50	2.254
	12.50	5.60	2.232	9.20	4.50	2.044	12.20	7.30	1.671
	20.60	12.00	1.716	7.10	3.90	1.820	8.50	4.90	1.734
	9.10	4.10	2.219	16.70	6.80	2.455	13.50	2.00	6.750
	7.20	2.40	3.000	5.60	3.10	1.806	10.70	4.80	2.229
	2.30	1.30	1.769	10.40	~~40.00~~ 4.00	0.260	8.00	4.30	1.860
	10.70	7.40	1.445	5.10	1.40	3.642	8.30	2.20	3.772
	10.60	3.50	3.028	5.40	3.50	1.542	7.00	4.80	1.458
	8.60	3.70	2.324	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 2.365
LOG AVE OF RATIOS = 0.32334
STANDARD DEVIATION = 0.793
95 PERCENT INTERVAL = 2.365 +/- 0.29

Missed fault
4.69 ratio

STATION CREEK (CRK) 0 DATE 12-03-70 RECORDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

	A	B	C	A	B	C	A	B	C
19A	9.80	3.30	2.969	5.80	1.30	4.461	5.00	2.45	2.040
	5.60	0.70	8.000	4.60	2.15	2.139	8.20	1.50	5.466
	4.60	2.60	1.769	4.90	1.60	3.062	8.00	3.80	2.105
	8.50	3.20	2.656	5.90	1.00	5.900	6.30	1.10	5.727
	6.50	1.45	4.482	6.45	2.20	2.931	5.10	1.40	3.642
	7.70	3.40	2.264	1.90	2.10	0.904	4.50	0.60	7.500
	4.50	1.10	4.090	7.45	1.70	4.382	21.30	5.50	3.872
	11.70	6.30	1.857	9.70	2.90	3.344	5.20	1.90	2.736
	5.00	1.20	4.166	4.30	1.50	2.866	4.30	1.80	2.388
	5.70	1.50	3.800	2.90	1.05	2.761	2.00	0.75	2.666
	7.70	3.40	2.264	4.80	1.00	4.800	6.80	2.80	2.428
	6.50	1.70	3.823	>3.50	~~1.90~~	1.842	6.30	2.10	3.000
	7.80	3.90	2.000	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 3.435
LOG AVE OF RATIOS = 0.49464
STANDARD DEVIATION = 1.207
95 PERCENT INTERVAL = 3.435 +/- 0.38

≈ 150' / 4.25 [illegible] of St

STATION CREEK (CRK) 1 DATE 12-03-70 RECORDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
8.00	1.90	4.210	2.60	0.70	3.714	4.30	1.40	3.071
7.90	1.80	4.388	4.20	4.60	0.913	4.20	2.70	1.555
6.00	2.90	2.068	5.00	1.25	4.000	3.00	3.00	1.000
3.20	2.40	1.333	10.00	3.60	2.777	6.00	1.30	4.615
1.80	1.30	1.384	2.10	1.15	1.826	4.70	4.30	1.093
2.30	1.25	1.840	5.50	5.20	1.057	28.90	7.30	3.958
2.10	1.60	1.312	3.50	0.45	7.777	2.90	2.30	1.260
2.20	0.90	2.444	5.40	1.60	3.375	10.20	4.10	2.487
8.20	1.60	5.125	21 > ~~7.90~~	~~1.10~~	7.181	9.00	3.90	2.307
2.50	1.80	1.388	4.70	3.50	1.342	4.70	1.30	3.615
5.00	1.00	5.000	7.00	2.00	3.500	3.60	1.20	3.000
3.60	1.30	2.769	10.00	1.40	7.142	3.60	1.30	2.769
3.50	0.80	4.375	3.60	0.80	4.500	8.50	2.50	3.400
3.00	1.20	2.500	5.30	1.10	4.818	3.30	1.50	2.200
11.50	2.20	5.227	13.00	1.30	10.000	6.50	0.90	7.222
7.00	1.00	7.000	6.30	0.90	7.000	10.60	0.80	13.250
6.10	0.70	8.714	10.40	1.00	10.400	6.60	0.70	9.428
8.70	2.30	3.782	10.00	2.00	5.000	0.00	0.00	0.000
0.00	0.00	0.000	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 4.102
LOG AVE OF RATIOS = 0.51774
STANDARD DEVIATION = 1.342
95 PERCENT INTERVAL = 4.102 +/- 0.36

Sta = 4.25 DWP

RS

STATION CREEK (CRK) 2A DATE 12-03-70 RECORDER GEORGE BARNETT(N75W)

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

	A	B	C	A	B	C	A	B	C
22	12.20	2.05	5.951	5.90	1.80	3.277	8.10	1.20	6.750
	3.40	1.90	1.789	8.20	1.70	4.823	20.00	4.60	4.347
	2.40	0.80	3.000	2.20	0.60	3.666	5.00	1.35	3.703
	14.20	3.05	4.655	2.60	1.20	2.166	3.60	0.60	6.000
	3.65	1.10	3.318	6.60	0.80	8.250	3.60	1.00	3.600
	2.50	0.65	3.846	3.55	1.40	2.535	5.20	1.20	4.333
	3.20	0.85	3.764	5.30	1.30	4.076	3.45	0.50	6.900
	5.90	1.10	5.363	7.40	1.30	5.692	5.70	1.45	3.931
	7.40	1.35	5.481	3.30	0.90	3.666	3.90	1.00	3.900
	6.20	2.05	3.024	5.60	1.40	4.000	4.20	0.80	5.250
	5.80	1.40	4.142	4.40	1.00	4.400	6.50	1.20	5.416
	6.00	1.20	5.000	15.70	3.00	5.233	3.80	1.00	3.800
	14.20	4.00	3.550	7.00	2.60	2.692	10.10	3.30	3.060
	4.80	1.00	4.800	3.10	0.90	3.444	6.80	1.20	5.666
	8.40	1.20	7.000	5.90	2.20	2.681	4.40	1.30	3.384
	9.00	3.90	2.307	8.50	1.50	5.666	5.30	1.40	3.785
	8.30	1.40	5.928	7.70	1.60	4.812	6.10	1.10	5.545
	5.40	1.20	4.500	6.30	1.50	4.199	5.00	1.00	5.000
	8.00	1.00	8.000	5.90	0.90	6.555	3.30	1.50	2.200
	7.00	1.10	6.363	9.90	2.00	4.950	4.00	0.40	10.000
24 >	4.50	1.00	4.500	>1.90	~~6.40~~	0.296	0.10 1.80	0.40	4.500
	3.30	0.80	4.125	3.50	1.00	3.500	7.00	1.50	4.666
	3.50	1.20	2.916	8.70	1.40	6.214	6.10	3.50	1.742
	9.60	2.60	3.692	5.30	1.20	4.416	17.50	2.70	6.481
	10.60	2.80	3.785	6.30	1.30	4.846	13.00	3.00	4.333
	9.20	1.90	4.842	4.00	0.90	4.444	3.20	1.00	3.200
	2.70	0.70	3.857	4.20	0.80	5.250	3.50	0.70	5.000
	6.70	1.50	4.466	5.60	2.10	2.666	4.90	0.70	7.000
	4.20	0.80	5.250	7.40	1.10	6.727	7.60	1.00	7.600
	21.30	2.50	8.520	4.60	1.10	4.181	7.10	1.20	5.916
2	14.20	3.70	3.837	7.00	2.60	2.692	6.75	2.40	2.812
	7.70	1.60	4.812	11.80	2.50	4.720	4.25	0.80	5.312
	5.50	1.80	3.055	5.25	1.80	2.916	4.40	1.00	4.400
	19.10	3.50	5.457	>~~0.73~~12.20		2.050	>0.00	5.90	1.800

ARITH. AVE OF RATIOS = 4.541
LOG AVE OF RATIOS = 0.62592
STANDARD DEVIATION = 1.562
95 PERCENT INTERVAL = 4.541 +/- 0.30

= 6.59

3.0 1.0 (CRK) 2B GSB

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
5.00	1.15	4.347	5.60	2.30	2.434	3.00	1.10	2.727
4.10	2.30	1.782	8.40	1.80	4.666	6.70	3.50	1.914
2.50	1.00	2.500	2.40	1.10	2.181	7.00	1.05	6.666
8.40	1.70	4.941	4.95	1.10	4.500	5.50	4.10	1.341
3.60	0.95	3.789	4.10	2.10	1.952	2.20	0.40	5.500
8.50	5.80	1.465	4.50	1.65	2.727	10.70	2.30	4.652
6.80	2.50	2.720	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 3.305
LOG AVE OF RATIOS = 0.47427
STANDARD DEVIATION = 1.172
95 PERCENT INTERVAL = 3.305 +/- 0.52

$\bar{x}$ = 6.59 DWT

STATION RUFF SLOPE (RS) 1 DATE 12-03-70 REOCRDER RAMON SHANNON

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

	A	B	C	A	B	C	A	B	C	
26	13.00	4.50	2.888	23.50	6.00	3.916	17.50	4.00	4.375	
	7.50	1.80	4.166	8.70	2.00	4.350	3.60	1.00	3.600	
	2.00	0.70	2.857	4.50	0.80	5.625	8.50	2.00	4.250	
	12.00	3.50	3.428	4.30	1.10	3.909	5.20	1.60	3.250	
	5.30	1.70	3.117	3.60	0.80	4.500	2.30	0.90	2.555	
	11.50	4.00	2.875	27 4.30	1.90	2.263	8.00	~~3.70~~ 7.5	2.162	mid 7.5
	2.80	1.00	2.800	8.50	2.50	3.400	5.90	1.70	3.470	
	7.50	2.80	2.678	11.20	3.80	2.947	6.20	4.30	1.441	
	9.70	2.50	3.880	5.50	~~0.60~~	~~9.166~~	6.40	3.10	2.064	mid
	5.40	2.90	1.862	5.20	2.80	1.857	26.70	5.20	5.134	
	10.30	1.70	6.058	8.60	2.30	3.739	8.60	2.20	3.909	
	12.00	3.00	4.000	11.40	0.90	12.666	7.00	1.90	3.684	
	7.70	2.40	3.208	12.20	2.60	4.692	7.50	1.50	5.000	
	3.40	0.60	5.666	4.80	1.90	2.526	0.00	0.00	0.000	
	0.00	0.00	0.000	0.00	0.00	0.000	0.00	0.00	0.000	

ARITH. AVE OF RATIOS = 3.901
LOG AVE OF RATIOS = 0.55186 ≈ 1600' N. CRK 2
STANDARD DEVIATION = 1.364
95 PERCENT INTERVAL = 3.901 +/- 0.41

STATION RUFF SLOPE (RS) 2 DATE 12-03-70 RECORDER RMAON SHANNON

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

	A	B	C	A	B	C	A	B	C	
25	4.00	0.90	4.444	3.50	0.70	5.000	4.10	1.20	3.416	
	3.10	0.80	3.875	4.60	1.20	3.833	4.50	2.10	2.142	
	5.00	1.00	5.000	4.20	1.50	2.800	4.30	0.80	5.375	
	6.50	1.20	5.416	3.80	0.80	4.750	2.20	0.60	3.666	
	4.00	0.80	5.000	3.80	0.70	5.428	5.30	1.90	2.789	
	5.60	1.70	3.294	5.10	1.90	2.684	2.20	0.90	2.444	
	6.50	2.00	3.250	6.30	1.50	4.199	2.20	1.10	2.000	
	7.20	1.30	5.538	4.20	2.00	2.100	10.30	1.50	6.866	
	6.00	1.50	4.000	4.70	2.20	2.136	2.10	0.70	3.000	
	5.00	1.50	3.333	11.50	3.00	3.833	8.00	2.00	4.000	
29	7.10	1.80	3.944	7.80	~~6.50~~	0.138	2.45	1.00	2.450	5.65
	9.20	2.40	3.833	3.90	1.50	2.599	3.00	0.55	5.454	
	2.50	0.60	4.166	4.20	0.50	8.400	7.80	2.50	3.119	
	11.80	2.20	5.363	3.70	4.65	0.795	5.20	1.70	3.058	
	3.90	1.15	3.391	4.85	1.70	2.852	2.80	1.80	1.555	
	4.30	2.10	2.047	4.80	1.55	3.096	4.00	1.10	3.636	
	2.90	1.00	2.900	6.50	2.70	2.407	2.80	0.25	11.200	
	4.80	1.20	4.000	4.60	1.40	3.285	3.10	0.90	3.444	
	5.85	1.45	4.034	9.00	3.20	2.812	0.00	0.00	0.000	
	0.00	0.00	0.000	0.00	0.00	0.000	0.00	0.00	0.000	

ARITH. AVE OF RATIOS = 3.743 ≈ 1600' ACK-1
LOG AVE OF RATIOS = 0.51897
STANDARD DEVIATION = 1.278
95 PERCENT INTERVAL = 3.743 +/- 0.33

STATION SUM BANK (SB) 1 DATE 12-02-70 RECORDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

	A	B	C	A	B	C		A	B	C
30	9.20	3.10	2.967	6.20	1.40	4.428		4.20	1.30	3.230
	8.30	1.60	5.187	10.80	1.10	9.818		7.10	0.95	7.473
	4.40	1.50	2.933	10.00	2.20	4.545		5.10	1.00	5.100
	2.50	2.05	1.219	5.20	1.40	3.714		4.40	0.50	8.800
	3.20	0.60	5.333	9.80	0.70	14.000		6.90	2.20	3.136
	8.00	2.40	3.333	6.50	1.30	5.000		8.00	1.50	5.333
	10.50	2.40	4.375	3.20	0.50	6.400		3.70	0.70	5.285
	8.60	2.30	3.739	3.80	0.80	4.750	31	5.20	2.00	2.600
	3.70	0.80	4.625	3.60	0.50	7.200		12.00	2.00	6.000
	6.20	1.40	4.428	12.90	3.00	4.300		6.20	2.10	2.952
	4.50	1.00	4.500	4.90	2.00	2.450		4.90	2.00	2.450
	4.00	0.80	5.000	3.30	0.90	3.666		8.20	1.40	5.857
	4.60	1.20	3.833	3.60	1.40	2.571		3.60	0.70	5.142
	5.50	1.00	5.500	6.20	1.20	5.166		3.10	0.70	4.428
	4.40	1.40	3.142	3.30	0.10	33.000		14.00	3.80	3.684
	13.10	1.50	8.733	6.70	1.40	4.785		7.60	1.80	4.222
	0.00	0.00	0.000	0.00	0.00	0.000		0.00	0.00	0.000

ARITH. AVE OF RATIOS = 5.423 ≈ 2000' Due E CRK-2
LOG AVE OF RATIOS = 0.66543
STANDARD DEVIATION = 1.784
95 PERCENT INTERVAL = 5.423 +/- 0.50

STATION SUM BANK (SB) 2 DATE 12-03-70 RECORDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
26.40	8.10	3.259	10.70	0.90	11.888	12.70	3.50	3.628
13.20	4.10	3.219	13.20	1.60	8.250	6.00	1.10	5.454
4.80	1.10	4.363	2.65	1.10	2.409	4.30	0.90	4.777
4.50	0.95	4.736	3.40	0.70	4.857	4.30	1.50	2.866
9.90	2.00	4.950	3.80	1.20	3.166	6.60	4.20	1.571
9.70	3.70	2.621	4.50	1.50	3.000	11.80	3.10	3.806
7.20	2.80	2.571	5.40	1.60	3.375	7.90	2.50	3.160
10.00	2.10	4.761	9.50	4.50	2.111	4.10	0.70	5.857
~~4.10~~	~~0.70~~	5.857	8.50	1.10	7.727	12.00	3.00	4.000
6.50	2.00	3.250	8.50	2.50	3.400	5.70	1.60	3.562
3.90	1.10	3.545	4.30	2.40	1.791	4.00	1.40	2.857
3.60	1.50	2.400	7.80	1.50	5.199	4.70	1.20	3.916
9.50	1.80	5.277	3.60	1.50	2.400	7.60	1.90	4.000
0.00	0.00	0.000	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 4.098
LOG AVE OF RATIOS = 0.57462
STANDARD DEVIATION = 1.430
95 PERCENT INTERVAL = 4.098 +/- 0.44

≈ 2000' ESE CRK 2

STATION TANK (TK) 1 DATE 12-04-70 RECORDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

	A	B	C	A	B	C		A	B	C
34	8.80	3.80	2.315	4.80	3.50	1.371		1.70	1.20	1.416
	2.00	1.70	1.176	1.80	0.90	2.000		6.80	3.20	2.125
	4.60	2.40	1.916	2.20	2.00	1.100		2.60	1.80	1.444
	4.70	1.70	2.764	3.60	3.30	1.090		4.40	2.60	1.692
	2.50	0.90	2.777	7.90	4.10	1.926		3.65	4.00	0.912
	2.30	1.10	2.090	4.70	1.70	2.764		2.90	1.35	2.148
	4.45	1.80	2.472	7.00	3.20	2.187	35	6.90	4.10	1.682
	4.50	1.60	2.812	8.30	2.70	3.074		7.50	1.10	6.818
	3.00	1.50	2.000	2.20	0.70	3.142		5.30	3.00	1.766
	4.00	2.40	1.666	5.10	2.20	2.318		3.20	0.80	4.000
	0.00	0.00	0.000	0.00	0.00	0.000		0.00	0.00	0.000

ARITH. AVE OF RATIOS = 2.232
LOG AVE OF RATIOS = 0.30968
STANDARD DEVIATION = 0.763
95 PERCENT INTERVAL = 2.232 +/- 0.27

STATION TANK (TK) 2 DATE 12-04-70 RECORDER RAMON SHANNON

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
> 8.50	0.70	12.142	18.00	4.00	4.500	9.40	2.00	4.700
10.20	3.50	2.914	10.50	7.90	1.329	4.60	1.70	2.705
1.50	1.50	1.000	5.80	1.50	3.866	4.60	2.00	2.300
3.90	1.10	3.545	4.80	1.00	4.800	9.30	1.40	6.642
10.00	5.50	1.818	3.10	1.20	2.583	2.60	1.10	2.363
8.00	1.80	4.444	3.00	2.00	1.500	8.30	1.00	8.300
8.60	2.50	3.440	10.20	3.00	3.400	> 3.60	~~3.10~~	1.161 2.1
10.50	3.50	3.000	4.30	2.20	1.954	8.65	4.70	1.840
12.30	3.00	4.100	4.70	1.10	4.272	2.10	1.05	2.000
3.20	1.40	2.285	47.10	12.70	3.708	8.60	2.50	3.440
8.00	4.10	1.951	4.30	2.30	1.869	5.90	2.80	2.107
14.60	4.50	3.244	5.60	2.90	1.931	3.30	1.70	1.941
20.20	9.00	2.244	9.10	4.00	2.275	9.70	5.30	1.830
8.30	3.60	2.305	10.40	3.20	3.250	11.20	1.10	10.181
6.60	1.30	5.076	7.40	2.10	3.523	0.00	0.00	0.000
0.00	0.00	0.000	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 3.404
LOG AVE OF RATIOS = 0.46528
STANDARD DEVIATION = 1.159
95 PERCENT INTERVAL = 3.404 +/- 0.34

STATION-POWER LINE (PL) 1 DATE 12-03-70 RECORDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
8.40	1.90	4.421	2.50	0.30	8.333	0.90	0.20	4.500
5.50	1.50	3.666	4.00	0.90	4.444	9.60	3.30	2.909
3.80	1.60	2.375	5.10	2.00	2.550	1.90	0.60	3.166
10.50	3.30	3.181	5.00	1.60	3.125	2.20	1.30	1.692
7.10	1.80	3.944	2.00	1.20	1.666	4.40	2.30	1.913
2.60	1.10	2.363	1.20	0.90	1.333	7.10	3.25	2.184
4.80	2.20	2.181	4.80	0.60	8.000	2.20	0.30	7.333
5.30	2.30	2.304	3.50	1.00	3.500	5.50	1.35	4.074
1.80	0.20	9.000	1.50	1.00	1.500	5.50	2.00	2.750
1.50	0.30	5.000	3.20	1.40	2.285	1.70	1.20	1.416
4.90	1.75	2.800	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 3.545
LOG AVE OF RATIOS = 0.49004
STANDARD DEVIATION = 1.223
95 PERCENT INTERVAL = 3.545 +/- 0.43

STATION POWER LINE (PL) 2 DATE 12-04-70 RECORDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

	A	B	C	A	B	C	A	B	C
32	3.90	1.00	3.900	14.00	1.10	12.727	13.50	4.00	3.375
	4.20	1.50	2.800	5.50	2.00	2.750	2.50	0.60	4.166
	16.10	0.20	80.500	7.20	2.20	3.272	2.80	1.40	2.000
	6.10	2.10	2.904	12.10	4.85	2.494	7.50	1.90	3.947
	2.00	0.40	5.000	2.20	0.50	4.400	3.20	0.70	4.571
	3.50	1.90	1.842	4.40	0.90	4.888	4.90	1.00	4.900
	28.50	2.60	10.961	3.50	1.00	3.500	38.00	7.60	5.000
	5.50	2.10	2.619	3.80	0.80	4.750	20.50	4.20	4.880
	10.70	4.90	2.183	7.80	1.80	4.333	6.20	2.00	3.100
	9.15	1.50	6.100	8.20	4.00	2.050	9.20	2.70	3.407
	4.60	1.10	4.181	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 6.693
LOG AVE OF RATIOS = 0.62387
STANDARD DEVIATION = 1.954
95 PERCENT INTERVAL = 6.693 +/- 0.68

STATION DEVIL'S CAN. EAST DCE 1A DATE 12-06-70 RECORDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

	A	B	C	A	B	C	A	B	C
40	3.05	0.50	6.100	3.80	2.40	1.583	4.30	4.40	0.977
	5.10	1.15	4.434	2.30	1.00	2.300	3.10	2.10	1.476
	4.50	1.30	3.461	1.20	1.05	1.142	2.30	0.60	3.833
	5.30	3.90	1.358	2.75	1.35	2.037	3.20	3.10	1.032
	4.55	0.80	5.687	17.30	3.85	4.493	10.70	2.80	3.821
	2.00	1.40	1.428	3.20	1.90	1.684	3.35	1.20	2.791
	1.35	1.20	1.125	5.50	0.90	6.111	> ~~4.00~~	2.20	1.818
	9.20	3.50	2.628	3.15	3.30	0.954	5.60	3.15	1.777
	12.50	1.90	6.578	6.50	1.20	5.416	4.60	2.10	2.190
	9.40	2.05	4.585	3.50	1.70	2.058	2.15	1.00	2.150
41	4.00	1.90	2.105	6.70	0.70	9.571	2.70	2.40	1.125
	4.30	1.20	3.583	8.20	4.15	1.975	4.60	1.20	3.833
	2.40	1.15	2.086	6.10	2.40	2.541	2.25	1.90	1.184
	8.70	4.00	2.175	3.00	2.45	1.224	5.00	1.50	3.333
	2.10	0.80	2.625	2.10	0.50	4.200	13.40	3.80	3.526
	9.50	1.60	5.937	3.50	1.65	2.121	8.10	1.60	5.062
	4.70	1.80	2.611	6.20	2.20	2.818	6.90	1.50	4.600
	4.40	2.10	2.095	8.30	3.20	2.593	5.50	1.60	3.437
	7.90	2.90	2.724	5.00	2.05	2.439	3.80	1.35	2.814
	4.10	1.50	2.733	4.00	1.65	2.424	5.30	2.20	2.409
	1.50	1.25	1.200	11.00	5.60	1.964	4.65	1.30	3.576
	3.00	2.70	1.111	5.90	4.00	1.475	2.20	1.90	1.157
	9.70	2.15	4.511	14.20	7.20	1.972	13.50	3.65	3.698
	2.75	0.80	3.437	3.00	0.80	3.750	1.90	2.20	0.863
	7.60	1.70	4.470	1.60	0.60	2.666	6.80	3.50	1.942
	3.70	1.80	2.055	9.40	2.30	4.086	6.60	1.55	4.258
	6.10	1.80	3.388	5.00	0.90	5.555	6.90	3.10	2.225
	3.20	2.00	1.600	5.90	3.90	1.512	4.40	3.80	1.157
	11.80	6.80	1.735	1.50	1.55	0.967	6.50	2.10	3.095
	14.00	2.10	6.666	13.00	8.10	1.604	6.60	4.00	1.650
	8.80	3.20	2.750	4.60	1.00	4.600	0.00	0.00	0.000
	0.00	0.00	0.000	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 2.887
LOG AVE OF RATIOS = 0.39759
STANDARD DEVIATION = 0.972
95 PERCENT INTERVAL = 2.887 +/- 0.19

STATION DEVIL'S CAN. EAST DCE 2A DATE 12-06-70 RECORDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

	A	B	C		A	B	C		A	B	C
43	6.00	2.10	2.857		11.30	3.70	3.054		5.90	1.00	5.900
	2.50	2.40	1.041		1.50	1.20	1.250		5.15	2.10	2.452
	14.20	6.20	2.290		3.10	1.10	2.818		9.80	4.20	2.333
	3.60	1.60	2.250		17.20	4.00	4.300		4.30	1.60	2.687
	6.90	2.60	2.653		3.10	3.00	1.033		6.20	1.65	3.757
	10.10	3.80	2.657		11.20	3.70	3.027		5.00	1.00	5.000
	3.35	0.60	5.583		7.00	2.80	2.500		2.75	0.65	4.230
	2.20	0.70	3.142		4.00	2.20	1.818		3.90	1.20	3.250
	3.70	1.50	2.466		4.20	1.10	3.818		5.70	1.30	4.384
	4.70	1.00	4.700		3.25	1.25	2.600		6.30	1.50	4.199
	3.75	0.90	4.166	44	4.50	3.20	1.406		13.10	1.50	8.733
	3.90	2.00	1.950		2.60	0.90	2.888		6.00	2.21	2.714
	6.80	1.90	3.578		4.10	1.40	2.928		2.30	1.80	1.277
	10.50	3.80	2.763		5.00	1.20	4.166		6.80	1.00	6.800
	6.00	3.45	1.739		3.50	1.90	1.842		7.10	1.50	4.733
	1.70	1.60	1.062		7.60	2.70	2.814		5.40	1.00	5.400
	8.80	2.90	3.034		2.70	1.10	2.454		3.20	0.60	5.333
	2.60	0.70	3.714		5.00	3.00	1.666		3.55	0.70	5.071
	2.30	1.50	1.533		2.80	0.70	4.000		1.20	0.90	1.333
	3.60	1.20	3.000		4.80	1.70	2.823		1.45	1.20	1.208
	2.35	0.90	2.611		1.80	2.00	0.900	45	9.20	4.50	2.044
	3.00	1.40	2.142		3.20	1.60	2.000		2.90	1.30	2.230
	10.80	2.10	5.142		5.90	2.00	2.950		8.50	2.60	3.269
	8.80	2.80	3.142		7.50	1.60	4.687		6.90	1.50	4.600
	6.10	1.70	3.588		1.65	0.90	1.833		2.60	1.15	2.260
	4.10	2.60	1.576		7.10	2.15	3.302		7.50	3.40	2.205
	5.90	2.80	2.107		7.50	2.00	3.750		3.60	2.20	1.636
	9.80	2.90	3.379		2.00	1.15	1.739		1.80	0.55	3.272
	7.00	2.30	3.043		5.80	1.80	3.222		10.80	1.80	6.000
	2.30	3.10	0.741		2.80	1.40	2.000		7.00	1.80	3.888
	26.50	6.40	4.140		3.10	2.40	1.291		3.50	1.50	2.333
	0.00	0.00	0.000		0.00	0.00	0.000		0.00	0.00	0.000

ARITH. AVE OF RATIOS = 3.045
LOG AVE OF RATIOS = 0.43610
STANDARD DEVIATION = 1.051
95 PERCENT INTERVAL = 3.045 +/- 0.21

STATION DEVIL'S CAN. EAST DCE 3 DATE 12-06-70

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

	A	B	C	A	B	C	A	B	C	
46	26.10	11.00	2.372	8.60	3.00	2.866	7.70	1.50	5.133	
	6.80	1.60	4.250	5.40	1.00	5.400	3.00	1.35	2.222	
	3.10	1.50	2.066	6.90	1.70	4.058	6.80	3.00	2.266	
	4.60	1.08	4.259	20.00	7.00	2.857	8.00	5.10	1.568	
	8.80	1.70	5.176	8.50	2.70	3.148	4.70	1.05	4.476	
	7.60	2.50	3.040	4.20	1.40	3.000	4.60	2.50	1.840	
	3.40	0.90	3.777	4.60	1.50	3.066	>~~3.50~~	1.50	2.333	3.55
	5.10	3.50	1.457	5.70	2.70	2.111	3.60	1.50	2.400	
	6.50	2.10	3.095	4.50	2.00	2.250	3.70	1.10	3.363	
	3.20	0.80	4.000	1.40	1.70	0.823	2.60	0.90	2.888	
	6.70	2.60	2.576	0.00	0.00	0.000	0.00	0.00	0.000	

ARITH. AVE OF RATIOS = 3.037
LOG AVE OF RATIOS = 0.45024
STANDARD DEVIATION = 1.082
95 PERCENT INTERVAL = 3.037 +/- 0.38

STATION DEVIL'S CAN. EAST DCE 4 DATE 12-06-70 RECORDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

	A	B	C	A	B	C	A	B	C
47	3.20	1.30	2.461	7.20	3.30	2.181	6.20	1.90	3.263
	7.70	2.40	3.208	7.10	3.10	2.290	13.70	3.90	3.512
	3.50	3.00	1.166	4.00	3.30	1.212	4.40	4.50	0.977
	2.30	1.50	1.533	6.10	2.00	3.050	4.00	0.95	4.210
	10.30	4.00	2.575	5.00	1.10	4.545	5.00	0.10	50.000
	2.00	0.90	2.222	3.50	1.20	2.916	12.20	7.80	1.564
	4.75	2.10	2.261	5.00	1.60	3.125	2.20	1.10	2.000
	5.30	1.00	5.300	6.60	1.80	3.666	3.30	1.10	3.000
	5.50	1.60	3.437	14.20	5.60	2.535	4.50	2.00	2.250
	9.00	2.00	4.500	4.00	1.10	3.636	3.00	1.30	2.307
	4.40	1.40	3.142	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 4.324
LOG AVE OF RATIOS = 0.45634
STANDARD DEVIATION = 1.319
95 PERCENT INTERVAL = 4.324 +/- 0.46

STATION DEVIL'S CAN. EAST DCE 5 DATE 12-06-70 RECORDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

48

A	B	C	A	B	C	A	B	C
8.40	2.60	3.230	2.30	2.30	1.000	7.40	3.10	2.387
3.80	1.80	2.111	10.00	1.10	9.090	5.10	1.70	3.000
10.80	3.80	2.842	6.30	1.90	3.315	3.20	1.00	3.200
1.60	0.80	2.000	5.10	1.60	3.187	12.00	2.00	6.000
11.90	2.20	5.409	10.80	2.60	4.153	8.80	2.00	4.400
2.50	0.80	3.125	4.20	3.60	1.166	5.00	1.30	3.846
5.20	2.80	1.857	1.70	0.20	8.500	3.20	0.70	4.571
4.20	2.00	2.100	2.80	2.20	1.272	8.00	2.50	3.200
1.90	1.50	1.266	8.10	1.40	5.785	2.95	1.50	1.966
2.70	0.60	4.500	3.00	2.10	1.428	1.00	0.90	1.111
1.10	0.90	1.222	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 3.298
LOG AVE OF RATIOS = 0.44327
STANDARD DEVIATION = 1.113
95 PERCENT INTERVAL = 3.298 +/- 0.39

ASARCO DACITE DATA

Combined Readings - Ratios
Corrected Data

George S. Barnett April 20, 1971

ASARCO DACITE DATA SH-1 SAMPLES TAKEN 11/12/70 BY RAMON SHANNON

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
1.50	0.50	3.000	3.20	0.70	4.571	1.90	0.40	4.750
2.60	0.70	3.714	4.50	0.80	5.625	6.00	1.00	6.000
2.60	0.40	6.500	2.40	0.40	6.000	1.50	0.50	3.000
4.50	1.70	2.647	2.20	0.40	5.500	2.80	1.00	2.800
1.40	0.40	3.500	1.80	0.40	4.500	14.25	2.20	6.477
2.20	0.50	4.400	6.20	1.00	6.200	5.50	1.70	3.235
1.10	0.20	5.500	3.40	0.50	6.800	5.90	0.50	11.800
5.80	1.10	5.272	3.70	0.50	7.400	10.00	0.80	12.500
10.80	1.80	6.000	6.20	3.20	1.937	6.00	0.85	7.058
15.80	2.40	6.583	3.90	0.60	6.500	5.70	1.50	3.800
6.40	1.70	3.764	3.00	1.60	1.875	5.00	1.10	4.545
3.30	1.50	2.200	8.40	1.50	5.600	7.20	2.00	3.600
11.35	3.70	3.067	7.30	2.00	3.650	11.70	3.80	3.078
15.40	2.60	5.923	8.30	1.40	5.928	12.10	1.90	6.368
5.80	2.30	2.521	4.00	0.50	8.000	0.00	0.00	0.000
0.00	0.00	0.000	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 5.084
LOG AVE OF RATIOS = 0.66699
STANDARD DEVIATION = 1.726
95 PERCENT INTERVAL = 5.084 +/- 0.51

STATION SHAFT SH2 DATE 11-12-70 RECORDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
3.50	0.80	4.375	3.30	1.20	2.750	9.00	1.50	6.000
9.50	2.60	3.653	4.20	1.10	3.818	5.30	1.60	3.312
3.40	1.20	2.833	10.50	3.10	3.387	5.00	0.70	7.142
4.00	1.00	4.000	9.00	1.10	8.181	2.70	1.10	2.454
4.70	1.20	3.916	1.70	0.70	2.428	7.20	1.40	5.142
2.80	1.10	2.545	3.50	0.85	4.117	6.00	2.20	2.727
6.20	1.10	5.636	4.60	1.90	2.421	2.70	0.35	7.714
3.50	0.80	4.375	4.40	1.20	3.666	2.50	0.45	5.555
3.20	1.00	3.200	3.40	0.70	4.857	2.50	0.35	7.142
6.10	1.50	4.066	6.20	0.70	8.857	3.20	1.10	2.909
2.50	0.40	6.250	4.00	0.50	8.000	3.30	0.80	4.125
5.00	0.80	6.250	3.40	1.10	3.090	5.60	2.00	2.800
3.20	0.90	3.555	4.00	1.70	2.352	2.90	0.60	4.833
2.50	0.70	3.571	3.10	0.50	6.200	4.80	1.50	3.200
0.34	0.40	0.850	4.50	0.70	6.428	4.10	8.00	0.512
0.00	0.00	0.000	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 4.337
LOG AVE OF RATIOS = 0.58665
STANDARD DEVIATION = 1.481
95 PERCENT INTERVAL = 4.337 +/- 0.43

STATION SHAFT SH 3 DATE 11-12-70 RECORDER RAMON SHANNON

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
3.70	0.70	5.285	2.30	0.60	3.833	4.70	0.40	11.750
1.80	0.70	2.571	3.30	0.80	4.125	1.70	0.60	2.833
3.00	0.60	5.000	2.30	0.40	5.750	2.70	0.70	3.857
3.30	0.40	8.250	3.00	0.70	4.285	4.20	0.80	5.250
3.40	0.70	4.857	2.90	0.60	4.833	3.30	0.70	4.714
2.70	0.60	4.500	1.40	0.20	7.000	2.70	0.60	4.500
1.20	0.30	4.000	2.00	0.40	5.000	3.70	1.30	2.846
2.10	0.30	7.000	1.50	0.60	2.500	4.00	0.60	6.666
2.60	0.60	4.333	9.70	1.30	7.461	10.70	1.40	7.642
6.80	1.50	4.533	4.00	0.60	6.666	9.50	1.50	6.333
9.20	0.95	9.684	3.00	0.60	5.000	5.50	1.20	4.583
4.20	0.25	16.800	5.40	1.70	3.176	5.10	1.15	4.434
8.50	0.95	8.947	3.20	1.10	2.909	7.10	1.20	5.916
3.00	0.80	3.750	3.00	1.00	3.000	5.50	0.50	11.000
4.10	1.00	4.100	12.15	3.10	3.919	4.30	0.50	8.600
15.00	2.70	5.555	2.80	4.50	0.622	4.90	1.00	4.900
3.40	1.10	3.090	2.50	0.40	6.250	4.70	1.65	2.848
7.60	1.80	4.222	5.50	0.60	9.166	2.40	0.90	2.666
0.00	0.00	0.000	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 5.431
LOG AVE OF RATIOS = 0.68490
STANDARD DEVIATION = 1.806
95 PERCENT INTERVAL = 5.431 +/- 0.48

STATION SUTTON'S SUMMIT SS 1 DATE 11-24-70 RECORDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
6.60	1.20	5.500	13.60	1.75	7.771	2.50	0.80	3.125
7.50	2.20	3.409	6.00	1.80	3.333	2.20	0.60	3.666
2.10	0.70	3.000	2.10	0.30	7.000	1.40	0.40	3.500
3.40	0.60	5.666	4.00	0.70	5.714	35.00	6.60	5.303
21.10	4.30	4.906	16.70	3.70	4.513	7.80	2.10	3.714
3.50	0.80	4.375	6.10	1.00	6.100	2.90	2.90	1.000
3.20	3.40	0.941	9.00	5.20	1.730	3.40	3.25	1.046
3.40	1.40	2.428	2.20	0.70	3.142	3.60	1.40	2.571
3.40	1.30	2.615	2.40	1.30	1.846	1.70	0.40	4.250
5.00	2.80	1.785	2.70	0.30	9.000	5.90	1.90	3.105
2.10	1.70	1.235	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 3.783
LOG AVE OF RATIOS = 0.51014
STANDARD DEVIATION = 1.287
95 PERCENT INTERVAL = 3.783 +/- 0.45

STATION-SUTTON'S SUMMIT (SS) 2 DATE 11-24 70 RECORDER RAMON SHANNON

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
8.50	3.40	2.500	4.00	1.10	3.636	4.80	1.40	3.428
6.00	1.10	5.454	2.20	0.90	2.444	2.60	0.80	3.250
3.50	1.30	2.692	5.00	1.80	2.777	3.70	1.00	3.700
6.00	1.90	3.157	11.50	4.00	2.875	6.60	2.20	3.000
4.90	1.10	4.454	1.80	0.50	3.600	3.40	0.60	5.666
7.00	1.50	4.666	6.00	1.00	6.000	2.10	0.60	3.500
8.00	2.00	4.000	4.70	0.80	5.875	3.50	0.40	8.750
13.50	2.40	5.625	9.50	2.00	4.750	5.00	1.00	5.000
2.50	0.50	5.000	7.40	1.20	6.166	5.50	1.20	4.583
6.30	2.00	3.150	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 4.275
LOG AVE OF RATIOS = 0.60873
STANDARD DEVIATION = 1.514
95 PERCENT INTERVAL = 4.275 +/- 0.56

STATION-SUTTON'S SUMMIT (SS) 3 DATE 11-24-70 RECORDER RAMON SHANNON

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
14.00	3.00	4.666	8.50	2.00	4.250	3.80	1.40	2.714
9.00	2.50	3.600	4.90	1.00	4.900	5.20	0.70	7.428
1.20	0.50	2.400	8.00	2.50	3.200	3.40	1.20	2.833
7.80	1.80	4.333	8.00	1.50	5.333	3.70	0.80	4.625
12.00	1.60	7.500	4.70	0.60	7.833	6.00	0.70	8.571
6.50	0.60	10.833	5.10	3.00	1.700	8.00	1.00	8.000
5.40	2.00	2.700	5.50	2.00	2.750	3.00	0.80	3.750
7.70	1.50	5.133	5.80	1.60	3.625	3.50	1.70	2.058
14.50	2.40	6.041	10.70	1.20	8.916	8.40	0.25	33.600
5.10	1.40	3.642	7.80	2.20	3.545	3.80	1.00	3.800
12.00	3.40	3.529	4.50	1.80	2.500	6.30	1.40	4.500
3.80	0.25	15.200	2.80	0.20	14.000	4.00	0.80	5.000
3.50	0.55	6.363	2.50	0.30	8.333	4.70	0.55	8.545
9.40	1.75	5.371	7.80	1.40	5.571	2.15	0.50	4.300
5.00	1.10	4.545	7.20	1.00	7.200	3.50	0.23	15.217
5.00	0.55	9.090	6.80	1.10	6.181	2.25	0.50	4.500
4.20	0.55	7.636	2.40	0.50	4.800	1.80	0.45	4.000
8.00	2.30	3.478	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 6.233
LOG AVE OF RATIOS = 0.71656
STANDARD DEVIATION = 1.992
95 PERCENT INTERVAL = 6.233 +/- 0.54

STATION JI RANCH JI 1 DATE 11-24-70 RECORDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
9.00	1.20	7.500	5.00	2.80	1.785	3.00	1.05	2.857
4.30	1.00	4.300	2.00	0.70	2.857	13.00	4.20	3.095
6.10	3.00	2.033	2.50	1.30	1.923	9.10	3.60	2.527
11.85	5.30	2.235	5.60	4.50	1.244	3.30	3.00	1.100
3.70	2.90	1.275	6.55	1.80	3.638	9.10	1.10	8.272
11.30	3.80	2.973	3.50	0.80	4.375	7.70	2.40	3.208
3.90	1.00	3.900	5.30	1.10	4.818	22.00	6.00	3.666
1.70	0.30	5.666	7.00	1.50	4.666	6.50	3.50	1.857
4.50	1.20	3.750	2.30	0.70	3.285	5.40	0.90	6.000
4.60	0.70	6.571	7.50	0.60	12.500	3.70	0.80	4.625
6.00	1.50	4.000	7.00	0.10	70.000	1.80	1.30	1.384
4.80	1.20	4.000	8.80	1.30	6.769	2.50	1.70	1.470
1.70	0.80	2.125	4.50	1.00	4.500	6.30	1.80	3.500
2.80	0.50	5.600	4.10	0.90	4.555	4.90	0.40	12.250
4.90	1.10	4.454	4.50	0.90	5.000	0.00	0.00	0.000
0.00	0.00	0.000	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 5.639
LOG AVE OF RATIOS = 0.57686
STANDARD DEVIATION = 1.699
95 PERCENT INTERVAL = 5.639 +/- 0.50

STATION JI RANCH JI 2 DATE 11-24-70 RECORDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
7.30	2.30	3.173	8.00	3.00	2.666	7.40	0.70	10.571
14.00	5.00	2.800	17.10	3.50	4.885	13.50	8.80	1.534
10.60	4.10	2.585	7.20	2.00	3.600	9.30	3.40	2.735
17.50	4.60	3.804	8.90	1.30	6.846	7.10	0.80	8.875
10.70	1.50	7.133	12.20	2.70	4.518	8.20	0.85	9.647
20.80	3.20	6.500	18.20	4.50	4.044	13.20	5.10	2.588
15.30	2.00	7.650	7.90	2.40	3.291	4.70	2.10	2.238
4.40	0.80	5.500	2.20	0.80	2.750	11.70	3.90	3.000
9.50	3.50	2.714	2.10	1.05	2.000	6.90	1.10	6.272
6.30	2.60	2.423	7.20	1.80	4.000	11.60	7.00	1.657
8.00	1.00	8.000	4.20	0.70	6.000	16.20	7.50	2.160
2.70	0.50	5.400	15.10	6.50	2.323	10.00	4.00	2.500
17.00	3.20	5.312	14.40	4.10	3.512	17.80	3.20	5.562
0.00	0.00	0.000	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 4.430
LOG AVE OF RATIOS = 0.59083
STANDARD DEVIATION = 1.509
95 PERCENT INTERVAL = 4.430 +/- 0.47

STATION OAK FLAT (OF) 1 DATE 11-25-70 RECORDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
3.40	0.60	5.666	2.50	1.15	2.173	9.20	3.30	2.787
2.50	1.00	2.500	2.90	1.10	2.636	2.20	2.10	1.047
10.50	6.10	1.721	11.50	7.20	1.597	13.80	4.80	2.875
17.10	9.80	1.744	13.10	3.60	3.638	11.90	3.90	3.051
14.40	3.60	4.000	10.30	5.80	1.775	7.20	3.20	2.250
12.90	6.40	2.015	8.50	5.00	1.700	6.00	4.40	1.363
9.00	5.10	1.764	26.20	9.60	2.729	4.15	3.80	1.092
4.60	4.00	1.150	4.00	4.10	0.975	4.40	2.60	1.692
3.20	4.20	0.761	13.30	7.20	1.847	7.20	3.80	1.894
3.50	2.90	1.206	2.40	1.80	1.333	0.00	0.00	0.000
0.00	0.00	0.000	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 2.103
LOG AVE OF RATIOS = 0.27811
STANDARD DEVIATION = 0.697
95 PERCENT INTERVAL = 2.103 +/- 0.25

STATION OAK FLAT (OF) 2 DATE 11-25-70 RECORDER GEORGE BARNETT

LENGTH = A
WEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
6.80	2.20	3.090	1.90	0.75	2.533	3.50	1.10	3.181
3.50	1.00	3.500	1.50	0.80	1.875	2.60	1.45	1.793
6.20	2.50	2.480	3.90	2.30	1.695	6.70	2.50	2.680
3.00	2.90	1.034	5.60	2.90	1.931	1.70	2.30	0.739
4.30	1.50	2.866	2.30	1.10	2.090	8.35	2.80	2.982
4.30	4.00	1.075	4.00	1.25	3.200	3.70	0.90	4.111
8.00	4.50	1.777	9.20	4.20	2.190	4.30	2.30	1.869
2.50	1.10	2.272	3.50	1.70	2.058	7.10	2.10	3.380
6.50	3.30	1.969	9.50	2.80	3.392	4.70	1.70	2.764
4.50	3.60	1.250	5.80	2.60	2.230	0.00	0.00	0.000
0.00	0.00	0.000	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 2.345
LOG AVE OF RATIOS = 0.34014
STANDARD DEVIATION = 0.822
95 PERCENT INTERVAL = 2.345 +/- 0.29

STATION OAK FLAT (OF) 3 DATE 11-25-70 RECORDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
7.50	1.90	3.947	8.10	1.25	6.480	7.50	3.20	2.343
5.55	1.75	3.171	3.70	2.00	1.850	3.40	1.35	2.518
3.50	1.20	2.916	8.30	3.00	2.766	4.20	2.30	1.826
6.00	2.80	2.142	3.60	1.40	2.571	4.55	1.80	2.527
9.30	3.70	2.513	3.10	1.30	2.384	4.00	1.85	2.162
3.50	1.20	2.916	3.20	1.20	2.666	1.30	1.55	0.838
4.30	2.20	1.954	2.40	1.15	2.086	3.10	1.10	2.818
8.10	3.80	2.131	2.70	1.40	1.928	2.00	2.10	0.952
4.10	2.20	1.863	3.30	1.60	2.062	11.20	4.70	2.382
0.00	0.00	0.000	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 2.471
LOG AVE OF RATIOS = 0.36302
STANDARD DEVIATION = 0.876
95 PERCENT INTERVAL = 2.471 +/- 0.33

STATION THROW NO. (235) 1 DATE 11-25-70 RECORDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
12.20	7.60	1.605	11.20	4.60	2.434	6.00	2.60	2.307
12.90	7.40	1.743	5.20	1.50	3.466	3.10	0.70	4.428
14.40	5.50	2.618	8.40	4.70	1.787	6.10	1.50	4.066
1.90	0.80	2.375	6.80	2.90	2.344	10.60	3.80	2.789
2.90	2.10	1.380	8.70	3.50	2.485	8.60	2.70	3.185
2.50	2.20	1.136	4.30	1.90	2.263	4.50	0.90	5.000
6.80	2.50	2.720	3.30	0.90	3.666	7.70	2.60	2.961
10.70	6.10	1.754	8.90	5.70	1.561	9.90	4.00	2.475
4.70	2.00	2.350	3.50	2.10	1.666	7.60	3.00	2.533
0.00	0.00	0.000	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 2.559
LOG AVE OF RATIOS = 0.38146
STANDARD DEVIATION = 0.915
95 PERCENT INTERVAL = 2.559 +/- 0.34

STATION THROW NO. (235) 2 DATE 11-25-70 RECORDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
4.20	1.00	4.200	5.00	2.15	2.325	2.80	1.05	2.666
18.60	11.30	1.646	12.30	5.20	2.365	12.40	5.50	2.254
12.50	5.60	2.232	9.20	4.50	2.044	12.20	7.30	1.671
20.60	12.00	1.716	7.10	3.90	1.820	8.50	4.90	1.734
9.10	4.10	2.219	16.70	6.80	2.455	13.50	2.00	6.750
7.20	2.40	3.000	5.60	3.10	1.806	10.70	4.80	2.229
2.30	1.30	1.769	10.40	4.00	2.600	8.00	4.30	1.860
10.70	7.40	1.445	5.10	1.40	3.642	8.30	2.20	3.772
10.60	3.50	3.028	5.40	3.50	1.542	7.00	4.80	1.458
8.60	3.70	2.324	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 2.449
LOG AVE OF RATIOS = 0.35906
STANDARD DEVIATION = 0.868
95 PERCENT INTERVAL = 2.449 +/- 0.32

STATION CREEK (CRK) 0 DATE 12-03-70 RECORDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
9.80	3.30	2.969	5.80	1.30	4.461	5.00	2.45	2.040
5.60	0.70	8.000	4.60	2.15	2.139	8.20	1.50	5.466
4.60	2.60	1.769	4.90	1.60	3.062	8.00	3.80	2.105
8.50	3.20	2.656	5.90	1.00	5.900	6.30	1.10	5.727
6.50	1.45	4.482	6.45	2.20	2.931	5.10	1.40	3.642
7.70	3.40	2.264	1.90	2.10	0.904	4.50	0.60	7.500
4.50	1.10	4.090	7.45	1.70	4.382	21.30	5.50	3.872
11.70	6.30	1.857	9.70	2.90	3.344	5.20	1.90	2.736
5.00	1.20	4.166	4.30	1.50	2.866	4.30	1.80	2.388
5.70	1.50	3.800	2.90	1.05	2.761	2.00	0.75	2.666
7.70	3.40	2.264	4.80	1.00	4.800	6.80	2.80	2.428
6.50	1.70	3.823	3.50	1.40	2.500	6.30	2.10	3.000
7.80	3.90	2.000	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 3.453
LOG AVE OF RATIOS = 0.49822
STANDARD DEVIATION = 1.215
95 PERCENT INTERVAL = 3.453 +/- 0.39

STATION CREEK (CRK) 1 DATE 12-03-70 RECORDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
8.00	1.90	4.210	2.60	0.70	3.714	4.30	1.40	3.071
7.90	1.80	4.388	4.20	4.60	0.913	4.20	2.70	1.555
6.00	2.90	2.068	5.00	1.25	4.000	3.00	3.00	1.000
3.20	2.40	1.333	10.00	3.60	2.777	6.00	1.30	4.615
1.80	1.30	1.384	2.10	1.15	1.826	4.70	4.30	1.093
2.30	1.25	1.840	5.50	5.20	1.057	28.90	7.30	3.958
2.10	1.60	1.312	3.50	0.45	7.777	2.90	2.30	1.260
2.20	0.90	2.444	5.40	1.60	3.375	10.20	4.10	2.487
8.20	1.60	5.125	8.90	1.10	8.090	9.00	3.90	2.307
2.50	1.80	1.388	4.70	3.50	1.342	4.70	1.30	3.615
5.00	1.00	5.000	7.00	2.00	3.500	3.60	1.20	3.000
3.60	1.30	2.769	10.00	1.40	7.142	3.60	1.30	2.769
3.50	0.80	4.375	3.60	0.80	4.500	8.50	2.50	3.400
3.00	1.20	2.500	5.30	1.10	4.818	3.30	1.50	2.200
11.50	2.20	5.227	13.00	1.30	10.000	6.50	0.90	7.222
7.00	1.00	7.000	6.30	0.90	7.000	10.60	0.80	13.250
6.10	0.70	8.714	10.40	1.00	10.400	6.60	0.70	9.428
8.70	2.30	3.782	10.00	2.00	5.000	0.00	0.00	0.000
0.00	0.00	0.000	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 4.119
LOG AVE OF RATIOS = 0.51871
STANDARD DEVIATION = 1.347
95 PERCENT INTERVAL = 4.119 +/- 0.36

STATION CREEK (CRK) 2A DATE 12-03-70 RECORDER GEORGE BARNETT(N75W)

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
12.20	2.05	5.951	5.90	1.80	3.277	8.10	1.20	6.750
3.40	1.90	1.789	8.20	1.70	4.823	20.00	4.60	4.347
2.40	0.80	3.000	2.20	0.60	3.666	5.00	1.35	3.703
14.20	3.05	4.655	2.60	1.20	2.166	3.60	0.60	6.000
3.65	1.10	3.318	6.60	0.80	8.250	3.60	1.00	3.600
2.50	0.65	3.846	3.55	1.40	2.535	5.20	1.20	4.333
3.20	0.85	3.764	5.30	1.30	4.076	3.45	0.50	6.900
5.90	1.10	5.363	7.40	1.30	5.692	5.70	1.45	3.931
7.40	1.35	5.481	3.30	0.90	3.666	3.90	1.00	3.900
6.20	2.05	3.024	5.60	1.40	4.000	4.20	0.80	5.250
5.80	1.40	4.142	4.40	1.00	4.400	6.50	1.20	5.416
6.00	1.20	5.000	15.70	3.00	5.233	3.80	1.00	3.800
14.20	4.00	3.550	7.00	2.60	2.692	10.10	3.30	3.060
4.80	1.00	4.800	3.10	0.90	3.444	6.80	1.20	5.666
8.40	1.20	7.000	5.90	2.20	2.681	4.40	1.30	3.384
9.00	3.90	2.307	8.50	1.50	5.666	5.30	1.40	3.785
8.30	1.40	5.928	7.70	1.60	4.812	6.10	1.10	5.545
5.40	1.20	4.500	6.30	1.50	4.199	5.00	1.00	5.000
8.00	1.00	8.000	5.90	0.90	6.555	3.30	1.50	2.200
7.00	1.10	6.363	9.90	2.00	4.950	4.00	0.40	10.000
0.00	0.00	0.000	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 4.585
LOG AVE OF RATIOS = 0.63615
STANDARD DEVIATION = 1.591
95 PERCENT INTERVAL = 4.585 +/- 0.40

STATION CREEK (CRK) 2B DATE 12-03-70 RECORDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
4.50	1.00	4.500	1.90	0.40	4.750	1.80	0.40	4.500
3.30	0.80	4.125	3.50	1.00	3.500	7.00	1.50	4.666
3.50	1.20	2.916	8.70	1.40	6.214	6.10	3.50	1.742
9.60	2.60	3.692	5.30	1.20	4.416	17.50	2.70	6.481
10.60	2.80	3.785	6.30	1.30	4.846	13.00	3.00	4.333
9.20	1.90	4.842	4.00	0.90	4.444	3.20	1.00	3.200
2.70	0.70	3.857	4.20	0.80	5.250	3.50	0.70	5.000
6.70	1.50	4.466	5.60	2.10	2.666	4.90	0.70	7.000
4.20	0.80	5.250	7.40	1.10	6.727	7.60	1.00	7.600
21.30	2.50	8.520	4.60	1.10	4.181	7.10	1.20	5.916
14.20	3.70	3.837	7.00	2.60	2.692	6.75	2.40	2.812
7.70	1.60	4.812	11.80	2.50	4.720	4.25	0.80	5.312
5.50	1.80	3.055	5.25	1.80	2.916	4.40	1.00	4.400
19.10	3.50	5.457	3.00	1.00	3.000	5.00	1.15	4.347
5.60	2.30	2.434	3.00	1.10	2.727	4.10	2.30	1.782
8.40	1.80	4.666	6.70	3.50	1.914	2.50	1.00	2.500
2.40	1.10	2.181	7.00	1.05	6.666	8.40	1.70	4.941
4.95	1.10	4.500	5.50	4.10	1.341	3.60	0.95	3.789
4.10	2.10	1.952	2.20	0.40	5.500	8.50	5.80	1.465
4.50	1.65	2.727	10.70	2.30	4.652	6.80	2.50	2.720
0.00	0.00	0.000	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 4.153
LOG AVE OF RATIOS = 0.58527
STANDARD DEVIATION = 1.446
95 PERCENT INTERVAL = 4.153 +/- 0.36

STATION RUFF SLOPE (RS) 1 DATE 12-03-70 RECORDER RAMON SHANNON

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
13.00	4.50	2.888	23.50	6.00	3.916	17.50	4.00	4.375
8.70	2.00	4.350	3.60	1.00	3.600	2.00	0.70	2.857
4.50	0.80	5.625	8.50	2.00	4.250	12.00	3.50	3.428
4.30	1.10	3.909	5.20	1.60	3.250	5.30	1.70	3.117
3.60	0.80	4.500	2.30	0.90	2.555	11.50	4.00	2.875
7.50	1.80	4.166	4.30	1.90	2.263	8.00	3.90	2.051
2.80	1.00	2.800	8.50	2.50	3.400	5.90	1.70	3.470
7.50	2.80	2.678	11.20	3.80	2.947	6.20	4.30	1.441
9.70	2.50	3.880	5.50	3.10	1.774	3.50	0.60	5.833
6.40	3.10	2.064	5.40	2.90	1.862	5.20	2.80	1.857
26.70	5.20	5.134	10.30	1.70	6.058	8.60	2.30	3.739
8.60	2.20	3.909	12.00	3.00	4.000	11.40	0.90	12.666
7.00	1.90	3.684	7.70	2.40	3.208	12.20	2.60	4.692
7.50	1.50	5.000	3.40	0.60	5.666	4.80	1.90	2.526
0.00	0.00	0.000	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 3.768
LOG AVE OF RATIOS = 0.53943
STANDARD DEVIATION = 1.324
95 PERCENT INTERVAL = 3.768 +/- 0.40

STATION RUFF SLOPE (RS) 2 DATE 12-03-70 RECORDER RMAON SHANNON

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
4.00	0.90	4.444	3.50	0.70	5.000	4.10	1.20	3.416
3.10	0.80	3.875	4.60	1.20	3.833	4.50	2.10	2.142
5.00	1.00	5.000	4.20	1.50	2.800	4.30	0.80	5.375
6.50	1.20	5.416	3.80	0.80	4.750	2.20	0.60	3.666
4.00	0.80	5.000	3.80	0.70	5.428	5.30	1.90	2.789
5.60	1.70	3.294	5.10	1.90	2.684	2.20	0.90	2.444
6.50	2.00	3.250	6.30	1.50	4.199	2.20	1.10	2.000
7.20	1.30	5.538	4.20	2.00	2.100	10.30	1.50	6.866
6.00	1.50	4.000	4.70	2.20	2.136	2.10	0.70	3.000
5.00	1.50	3.333	11.50	3.00	3.833	8.00	2.00	4.000
7.10	1.80	3.944	7.80	5.65	1.380	2.45	1.00	2.450
9.20	2.40	3.833	3.90	1.50	2.599	3.00	0.55	5.454
2.50	0.60	4.166	4.20	0.50	8.400	7.80	2.50	3.119
11.80	2.20	5.363	3.70	4.65	0.795	5.20	1.70	3.058
3.90	1.15	3.391	4.85	1.70	2.852	2.80	1.80	1.555
4.30	2.10	2.047	4.80	1.55	3.096	4.00	1.10	3.636
2.90	1.00	2.900	6.50	2.70	2.407	2.80	0.25	11.200
4.80	1.20	4.000	4.60	1.40	3.285	3.10	0.90	3.444
5.85	1.45	4.034	9.00	3.20	2.812	0.00	0.00	0.000
0.00	0.00	0.000	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 3.765
LOG AVE OF RATIOS = 0.53683
STANDARD DEVIATION = 1.314
95 PERCENT INTERVAL = 3.765 +/- 0.34

STATION SUM BANK (SB) 1 DATE 12-02-70 RECORDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
9.20	3.10	2.967	6.20	1.40	4.428	4.20	1.30	3.230
8.30	1.60	5.187	10.80	1.10	9.818	7.10	0.95	7.473
4.40	1.50	2.933	10.00	2.20	4.545	5.10	1.00	5.100
2.50	2.05	1.219	5.20	1.40	3.714	4.40	0.50	8.800
3.20	0.60	5.333	9.80	0.70	14.000	6.90	2.20	3.136
8.00	2.40	3.333	6.50	1.30	5.000	8.00	1.50	5.333
10.50	2.40	4.375	3.20	0.50	6.400	3.70	0.70	5.285
8.60	2.30	3.739	3.80	0.80	4.750	5.20	2.00	2.600
3.70	0.80	4.625	3.60	0.50	7.200	12.00	2.00	6.000
6.20	1.40	4.428	12.90	3.00	4.300	6.20	2.10	2.952
4.50	1.00	4.500	4.90	2.00	2.450	4.90	2.00	2.450
4.00	0.80	5.000	3.30	0.90	3.666	8.20	1.40	5.857
4.60	1.20	3.833	3.60	1.40	2.571	3.60	0.70	5.142
5.50	1.00	5.500	6.20	1.20	5.166	3.10	0.70	4.428
4.40	1.40	3.142	3.30	0.10	33.000	14.00	3.80	3.684
13.10	1.50	8.733	6.70	1.40	4.785	7.60	1.80	4.222
0.00	0.00	0.000	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 5.423
LOG AVE OF RATIOS = 0.66543
STANDARD DEVIATION = 1.784
95 PERCENT INTERVAL = 5.423 +/- 0.50

STATION SUM BANK (SB) 2 DATE 12-03-70 RECORDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
26.40	8.10	3.259	10.70	0.90	11.888	12.70	3.50	3.628
13.20	4.10	3.219	13.20	1.60	8.250	6.00	1.10	5.454
4.80	1.10	4.363	2.65	1.10	2.409	4.30	0.90	4.777
4.50	0.95	4.736	3.40	0.70	4.857	4.30	1.50	2.866
9.90	2.00	4.950	3.80	1.20	3.166	6.60	4.20	1.571
9.70	3.70	2.621	4.50	1.50	3.000	11.80	3.10	3.806
7.20	2.80	2.571	5.40	1.60	3.375	7.90	2.50	3.160
10.00	2.10	4.761	9.50	4.50	2.111	6.00	2.40	2.500
4.10	0.70	5.857	8.50	1.10	7.727	12.00	3.00	4.000
6.50	2.00	3.250	8.50	2.50	3.400	5.70	1.60	3.562
3.90	1.10	3.545	4.30	2.40	1.791	4.00	1.40	2.857
3.60	1.50	2.400	7.80	1.50	5.199	4.70	1.20	3.916
9.50	1.80	5.277	3.60	1.50	2.400	7.60	1.90	4.000
0.00	0.00	0.000	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 4.012
LOG AVE OF RATIOS = 0.56514
STANDARD DEVIATION = 1.402
95 PERCENT INTERVAL = 4.012 +/- 0.44

STATION TANK (TK) 1 DATE 12-04-70 RECORDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
8.80	3.80	2.315	4.80	3.50	1.371	1.70	1.20	1.416
2.00	1.70	1.176	1.80	0.90	2.000	6.80	3.20	2.125
4.60	2.40	1.916	2.20	2.00	1.100	2.60	1.80	1.444
4.70	1.70	2.764	3.60	3.30	1.090	4.40	2.60	1.692
2.50	0.90	2.777	7.90	4.10	1.926	3.65	4.00	0.912
2.30	1.10	2.090	4.70	1.70	2.764	2.90	1.35	2.148
4.45	1.80	2.472	7.00	3.20	2.187	6.90	4.10	1.682
4.50	1.60	2.812	8.30	2.70	3.074	7.50	1.10	6.818
3.00	1.50	2.000	2.20	0.70	3.142	5.30	3.00	1.766
4.00	2.40	1.666	5.10	2.20	2.318	3.20	0.80	4.000
0.00	0.00	0.000	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 2.232
LOG AVE OF RATIOS = 0.30968
STANDARD DEVIATION = 0.763
95 PERCENT INTERVAL = 2.232 +/- 0.27

STATION TANK (TK) 2 DATE 12-04-70 RECORDER RAMON SHANNON

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
9.50	0.70	13.571	18.00	4.00	4.500	9.40	2.00	4.700
10.20	3.50	2.914	10.50	7.90	1.329	4.60	1.70	2.705
1.50	1.50	1.000	5.80	1.50	3.866	4.60	2.00	2.300
3.90	1.10	3.545	4.80	1.00	4.800	9.30	1.40	6.642
10.00	5.50	1.818	3.10	1.20	2.583	2.60	1.10	2.363
8.00	1.80	4.444	3.00	2.00	1.500	8.30	1.00	8.300
8.60	2.50	3.440	10.20	3.00	3.400	3.60	2.10	1.714
10.50	3.50	3.000	4.30	2.20	1.954	8.65	4.70	1.840
12.30	3.00	4.100	4.70	1.10	4.272	2.10	1.05	2.000
3.20	1.40	2.285	47.10	12.70	3.708	8.60	2.50	3.440
8.00	4.10	1.951	4.30	2.30	1.869	5.90	2.80	2.107
14.60	4.50	3.244	5.60	2.90	1.931	3.30	1.70	1.941
20.20	9.00	2.244	9.10	4.00	2.275	9.70	5.30	1.830
8.30	3.60	2.305	10.40	3.20	3.250	11.20	1.10	10.181
6.60	1.30	5.076	7.40	2.10	3.523	0.00	0.00	0.000
0.00	0.00	0.000	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 3.449
LOG AVE OF RATIOS = 0.47022
STANDARD DEVIATION = 1.175
95 PERCENT INTERVAL = 3.449 +/- 0.34

STATION-POWER LINE (PL) 1 DATE 12-03-70 RECORDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
8.40	1.90	4.421	2.50	0.30	8.333	0.90	0.20	4.500
5.50	1.50	3.666	4.00	0.90	4.444	9.60	3.30	2.909
3.80	1.60	2.375	5.10	2.00	2.550	1.90	0.60	3.166
10.50	3.30	3.181	5.00	1.60	3.125	2.20	1.30	1.692
7.10	1.80	3.944	2.00	1.20	1.666	4.40	2.30	1.913
2.60	1.10	2.363	1.20	0.90	1.333	7.10	3.25	2.184
4.80	2.20	2.181	4.80	0.60	8.000	2.20	0.30	7.333
5.30	2.30	2.304	3.50	1.00	3.500	5.50	1.35	4.074
1.80	0.20	9.000	1.50	1.00	1.500	5.50	2.00	2.750
1.50	0.30	5.000	3.20	1.40	2.285	1.70	1.20	1.416
4.90	1.75	2.800	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 3.545
LOG AVE OF RATIOS = 0.49004
STANDARD DEVIATION = 1.223
95 PERCENT INTERVAL = 3.545 +/- 0.43

STATION POWER LINE (PL) 2 DATE 12-04-70 RECORDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
3.90	1.00	3.900	14.00	1.10	12.727	13.50	4.00	3.375
4.20	1.50	2.800	5.50	2.00	2.750	2.50	0.60	4.166
16.10	0.20	80.500	7.20	2.20	3.272	2.80	1.40	2.000
6.10	2.10	2.904	12.10	4.85	2.494	7.50	1.90	3.947
2.00	0.40	5.000	2.20	0.50	4.400	3.20	0.70	4.571
3.50	1.90	1.842	4.40	0.90	4.888	4.90	1.00	4.900
28.50	2.60	10.961	3.50	1.00	3.500	38.00	7.60	5.000
5.50	2.10	2.619	3.80	0.80	4.750	20.50	4.20	4.880
10.70	4.90	2.183	7.80	1.80	4.333	6.20	2.00	3.100
9.15	1.50	6.100	8.20	4.00	2.050	9.20	2.70	3.407
4.60	1.10	4.181	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 6.693
LOG AVE OF RATIOS = 0.62387
STANDARD DEVIATION = 1.954
95 PERCENT INTERVAL = 6.693 +/- 0.68

STATION DEVIL'S CAN. EAST DCE 1A DATE 12-06-70 RECORDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
3.05	0.50	6.100	3.80	2.40	1.583	4.30	4.40	0.977
5.10	1.15	4.434	2.30	1.00	2.300	3.10	2.10	1.476
4.50	1.30	3.461	1.20	1.05	1.142	2.30	0.60	3.833
5.30	3.90	1.358	2.75	1.35	2.037	3.20	3.10	1.032
4.55	0.80	5.687	17.30	3.85	4.493	10.70	2.80	3.821
2.00	1.40	1.428	3.20	1.90	1.684	3.35	1.20	2.791
1.35	1.20	1.125	5.50	0.90	6.111	4.80	2.20	2.181
9.20	3.50	2.628	3.15	3.30	0.954	5.60	3.15	1.777
12.50	1.90	6.578	6.50	1.20	5.416	4.60	2.10	2.190
9.40	2.05	4.585	3.50	1.70	2.058	2.15	1.00	2.150
4.00	1.90	2.105	6.70	0.70	9.571	2.70	2.40	1.125
4.30	1.20	3.583	8.20	4.15	1.975	4.60	1.20	3.833
2.40	1.15	2.086	6.10	2.40	2.541	2.25	1.90	1.184
8.70	4.00	2.175	3.00	2.45	1.224	5.00	1.50	3.333
2.10	0.80	2.625	2.10	0.50	4.200	13.40	3.80	3.526
9.50	1.60	5.937	3.50	1.65	2.121	8.10	1.60	5.062
4.70	1.80	2.611	6.20	2.20	2.818	6.90	1.50	4.600
4.40	2.10	2.095	8.30	3.20	2.593	5.50	1.60	3.437
7.90	2.90	2.724	5.00	2.05	2.439	3.80	1.35	2.814
4.10	1.50	2.733	4.00	1.65	2.424	5.30	2.20	2.409
1.50	1.25	1.200	11.00	5.60	1.964	4.65	1.30	3.576
3.00	2.70	1.111	5.90	4.00	1.475	2.20	1.90	1.157
9.70	2.15	4.511	14.20	7.20	1.972	13.50	3.65	3.698
2.75	0.80	3.437	3.00	0.80	3.750	1.90	2.20	0.863
7.60	1.70	4.470	1.60	0.60	2.666	6.80	3.50	1.942
3.70	1.80	2.055	9.40	2.30	4.086	6.60	1.55	4.258
6.10	1.80	3.388	5.00	0.90	5.555	6.90	3.10	2.225
3.20	2.00	1.600	5.90	3.90	1.512	4.40	3.80	1.157
11.80	6.80	1.735	1.50	1.55	0.967	6.50	2.10	3.095
14.00	2.10	6.666	13.00	8.10	1.604	6.60	4.00	1.650
8.80	3.20	2.750	4.60	1.00	4.600	0.00	0.00	0.000
0.00	0.00	0.000	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 2.891
LOG AVE OF RATIOS = 0.39845
STANDARD DEVIATION = 0.974
95 PERCENT INTERVAL = 2.891 +/- 0.19

STATION DEVIL'S CAN. EAST DCE 2A DATE 12-08-70 RECORDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
6.00	2.10	2.857	11.30	3.70	3.054	5.90	1.00	5.900
2.50	2.40	1.041	1.50	1.20	1.250	5.15	2.10	2.452
14.20	6.20	2.290	3.10	1.10	2.818	9.80	4.20	2.333
3.60	1.60	2.250	17.20	4.00	4.300	4.30	1.60	2.687
6.90	2.60	2.653	3.10	3.00	1.033	6.20	1.65	3.757
10.10	3.80	2.657	11.20	3.70	3.027	5.00	1.00	5.000
3.35	0.60	5.583	7.00	2.80	2.500	2.75	0.65	4.230
2.20	0.70	3.142	4.00	2.20	1.818	3.90	1.20	3.250
3.70	1.50	2.466	4.20	1.10	3.818	5.70	1.30	4.384
4.70	1.00	4.700	3.25	1.25	2.600	6.30	1.50	4.199
3.75	0.90	4.166	4.50	3.20	1.406	13.10	1.50	8.733
3.90	2.00	1.950	2.60	0.90	2.888	6.00	2.21	2.714
6.80	1.90	3.578	4.10	1.40	2.928	2.30	1.80	1.277
10.50	3.80	2.763	5.00	1.20	4.166	6.80	1.00	6.800
6.00	3.45	1.739	3.50	1.90	1.842	7.10	1.50	4.733
1.70	1.60	1.062	7.60	2.70	2.814	5.40	1.00	5.400
8.80	2.90	3.034	2.70	1.10	2.454	3.20	0.60	5.333
2.60	0.70	3.714	5.00	3.00	1.666	3.55	0.70	5.071
2.30	1.50	1.533	2.80	0.70	4.000	1.20	0.90	1.333
3.60	1.20	3.000	4.80	1.70	2.823	1.45	1.20	1.208
2.35	0.90	2.611	1.80	2.00	0.900	9.20	4.50	2.044
3.00	1.40	2.142	3.20	1.60	2.000	2.90	1.30	2.230
10.80	2.10	5.142	5.90	2.00	2.950	8.50	2.60	3.269
8.80	2.80	3.142	7.50	1.60	4.687	6.90	1.50	4.600
6.10	1.70	3.588	1.65	0.90	1.833	2.60	1.15	2.260
4.10	2.60	1.576	7.10	2.15	3.302	7.50	3.40	2.205
5.90	2.80	2.107	7.50	2.00	3.750	3.60	2.20	1.636
9.80	2.90	3.379	2.00	1.15	1.739	1.80	0.55	3.272
7.00	2.30	3.043	5.80	1.80	3.222	10.80	1.80	6.000
2.30	3.10	0.741	2.80	1.40	2.000	7.00	1.80	3.888
26.50	6.40	4.140	3.10	2.40	1.291	3.50	1.50	2.333
0.00	0.00	0.000	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 3.045
LOG AVE OF RATIOS = 0.43610
STANDARD DEVIATION = 1.051
95 PERCENT INTERVAL = 3.045 +/- 0.21

STATION DEVIL'S CAN. EAST DCE 3 DATE 12-06-70

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
26.10	11.00	2.372	8.60	3.00	2.866	7.70	1.50	5.133
6.80	1.60	4.250	5.40	1.00	5.400	3.00	1.35	2.222
3.10	1.50	2.066	6.90	1.70	4.058	6.80	3.00	2.266
4.60	1.08	4.259	20.00	7.00	2.857	8.00	5.10	1.568
8.80	1.70	5.176	8.50	2.70	3.148	4.70	1.05	4.476
7.60	2.50	3.040	4.20	1.40	3.000	4.60	2.50	1.840
3.40	0.90	3.777	4.60	1.50	3.066	3.55	1.50	2.366
5.10	3.50	1.457	5.70	2.70	2.111	3.60	1.50	2.400
6.50	2.10	3.095	4.50	2.00	2.250	3.70	1.10	3.363
3.20	0.80	4.000	1.40	1.70	0.823	2.60	0.90	2.888
6.70	2.60	2.576	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 3.038
LOG AVE OF RATIOS = 0.45044
STANDARD DEVIATION = 1.082
95 PERCENT INTERVAL = 3.038 +/- 0.38

STATION DEVIL'S CAN. EAST DCE 4 DATE 12-06-70 RECORDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
3.20	1.30	2.461	7.20	3.30	2.181	6.20	1.90	3.263
7.70	2.40	3.208	7.10	3.10	2.290	13.70	3.90	3.512
3.50	3.00	1.166	4.00	3.30	1.212	4.40	4.50	0.977
2.30	1.50	1.533	6.10	2.00	3.050	4.00	0.95	4.210
10.30	4.00	2.575	5.00	1.10	4.545	5.00	0.10	50.000
2.00	0.90	2.222	3.50	1.20	2.916	12.20	7.80	1.564
4.75	2.10	2.261	5.00	1.60	3.125	2.20	1.10	2.000
5.30	1.00	5.300	6.60	1.80	3.666	3.30	1.10	3.000
5.50	1.60	3.437	14.20	5.60	2.535	4.50	2.00	2.250
9.00	2.00	4.500	4.00	1.10	3.636	3.00	1.30	2.307
4.40	1.40	3.142	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 4.324
LOG AVE OF RATIOS = 0.45634
STANDARD DEVIATION = 1.319
95 PERCENT INTERVAL = 4.324 +/- 0.46

STATION DEVIL'S CAN. EAST DCE 5 DATE 12-06-70 RECORDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
8.40	2.60	3.230	2.30	2.30	1.000	7.40	3.10	2.387
3.80	1.80	2.111	10.00	1.10	9.090	5.10	1.70	3.000
10.80	3.80	2.842	6.30	1.90	3.315	3.20	1.00	3.200
1.60	0.80	2.000	5.10	1.60	3.187	12.00	2.00	6.000
11.90	2.20	5.409	10.80	2.60	4.153	8.80	2.00	4.400
2.50	0.80	3.125	4.20	3.60	1.166	5.00	1.30	3.846
5.20	2.80	1.857	1.70	0.20	8.500	3.20	0.70	4.571
4.20	2.00	2.100	2.80	2.20	1.272	8.00	2.50	3.200
1.90	1.50	1.266	8.10	1.40	5.785	2.95	1.50	1.966
2.70	0.60	4.500	3.00	2.10	1.428	1.00	0.90	1.111
1.10	0.90	1.222	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 3.298
LOG AVE OF RATIOS = 0.44327
STANDARD DEVIATION = 1.113
95 PERCENT INTERVAL = 3.298 +/- 0.39

TAB

Appendix D

SUMMARY OF RATIO CALCULATIONS AND
CALCULATIONS LESS DELETIONS OF
DR. D. W. PETERSON'S DATA

RELATION TO DACITE	STATION NAME	RATIO	TOTAL RATIO MINUS 2 READINGS	TOTAL RATIO MINUS 4 READINGS	TOTAL RATIO MINUS 6 READINGS	TOTAL RATIO MINUS 8 READINGS
1980' (top)	OF-1	1.224	--	--	--	--
1820'	SHA-15	1.683	--	--	--	--
1610'	SHA-13	2.0000	--	--	--	--
1590'	SHA-12	2.720	--	--	--	--
1450'	SHA-11	3.294	2.952	2.790	--	--
1300'	SHA-10	4.969	4.595	4.307	4.174	--
1075'	SHA-9	8.931	6.936	6.023	5.652	5.460
690' (Nearest to base)	SHA-7	24.087	21.206	19.915	18.749	17.683

ASARCO DACITE DATA

Ratio Calculations and
Calculations Less Deletions

Data by Dr. D. W. Peterson

George S. Barnett April 20, 1971

STATION OAK FLAT OF 1 (DWP) DATE 12-23-70

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
0.00	0.00	0.390	0.00	0.00	0.530	0.00	0.00	0.550
0.00	0.00	0.610	0.00	0.00	0.620	0.00	0.00	0.670
0.00	0.00	0.680	0.00	0.00	0.690	0.00	0.00	0.710
0.00	0.00	0.730	0.00	0.00	0.740	0.00	0.00	0.760
0.00	0.00	0.840	0.00	0.00	0.840	0.00	0.00	0.860
0.00	0.00	0.880	0.00	0.00	0.900	0.00	0.00	0.910
0.00	0.00	0.920	0.00	0.00	0.920	0.00	0.00	0.920
0.00	0.00	0.920	0.00	0.00	1.090	0.00	0.00	1.100
0.00	0.00	1.110	0.00	0.00	1.160	0.00	0.00	1.170
0.00	0.00	1.210	0.00	0.00	1.210	0.00	0.00	1.220
0.00	0.00	1.270	0.00	0.00	1.300	0.00	0.00	1.300
0.00	0.00	1.300	0.00	0.00	1.300	0.00	0.00	1.320
0.00	0.00	1.330	0.00	0.00	1.330	0.00	0.00	1.400
0.00	0.00	1.430	0.00	0.00	1.450	0.00	0.00	1.500
0.00	0.00	1.500	0.00	0.00	1.500	0.00	0.00	1.520
0.00	0.00	1.520	0.00	0.00	1.520	0.00	0.00	1.550
0.00	0.00	1.570	0.00	0.00	1.570	0.00	0.00	1.590
0.00	0.00	1.590	0.00	0.00	1.590	0.00	0.00	1.750
0.00	0.00	1.760	0.00	0.00	2.010	0.00	0.00	2.370
0.00	0.00	2.500	0.00	0.00	2.750	0.00	0.00	0.000
0.00	0.00	0.000	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 1.224
LOG AVE OF RATIOS = 0.05516
STANDARD DEVIATION = 0.188
95 PERCENT INTERVAL = 1.224 +/- 0.04

STATION SHAFT CHA 15 (DWP) DATE 12-23-70 RECORDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
0.00	0.00	0.870	0.00	0.00	0.990	0.00	0.00	1.010
0.00	0.00	1.020	0.00	0.00	1.050	0.00	0.00	1.050
0.00	0.00	1.070	0.00	0.00	1.070	0.00	0.00	1.130
0.00	0.00	1.150	0.00	0.00	1.240	0.00	0.00	1.270
0.00	0.00	1.320	0.00	0.00	1.330	0.00	0.00	1.340
0.00	0.00	1.380	0.00	0.00	1.440	0.00	0.00	1.450
0.00	0.00	1.560	0.00	0.00	1.570	0.00	0.00	1.580
0.00	0.00	1.610	0.00	0.00	1.630	0.00	0.00	1.650
0.00	0.00	1.670	0.00	0.00	1.680	0.00	0.00	1.720
0.00	0.00	1.740	0.00	0.00	1.750	0.00	0.00	1.800
0.00	0.00	1.900	0.00	0.00	1.920	0.00	0.00	2.200
0.00	0.00	2.250	0.00	0.00	2.360	0.00	0.00	2.400
0.00	0.00	2.540	0.00	0.00	2.550	0.00	0.00	2.600
0.00	0.00	2.810	0.00	0.00	4.340	0.00	0.00	0.000
0.00	0.00	0.000	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 1.683
LOG AVE OF RATIOS = 0.19903
STANDARD DEVIATION = 0.529
95 PERCENT INTERVAL = 1.683 +/- 0.16

STATION SHAFT SHA 13 (DWP) DATE 12-23-70 RECORDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
0.00	0.00	1.100	0.00	0.00	1.110	0.00	0.00	1.200
0.00	0.00	1.300	0.00	0.00	1.380	0.00	0.00	1.410
0.00	0.00	1.420	0.00	0.00	1.480	0.00	0.00	1.500
0.00	0.00	1.500	0.00	0.00	1.500	0.00	0.00	1.600
0.00	0.00	1.600	0.00	0.00	1.700	0.00	0.00	1.700
0.00	0.00	1.800	0.00	0.00	1.800	0.00	0.00	1.900
0.00	0.00	1.900	0.00	0.00	1.900	0.00	0.00	1.900
0.00	0.00	1.950	0.00	0.00	2.020	0.00	0.00	2.100
0.00	0.00	2.200	0.00	0.00	2.300	0.00	0.00	2.300
0.00	0.00	2.300	0.00	0.00	2.300	0.00	0.00	2.500
0.00	0.00	2.500	0.00	0.00	2.620	0.00	0.00	2.700
0.00	0.00	2.750	0.00	0.00	2.800	0.00	0.00	3.180
0.00	0.00	3.200	0.00	0.00	3.600	0.00	0.00	0.000
0.00	0.00	0.000	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 2.000
LOG AVE OF RATIOS = 0.28203
STANDARD DEVIATION = 0.693
95 PERCENT INTERVAL = 2.000 +/- 0.22

STATION SHAFT CHA 12 (DWP) DATE 12-23-70 RECORDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
0.00	0.00	1.390	0.00	0.00	1.500	0.00	0.00	1.700
0.00	0.00	1.700	0.00	0.00	1.700	0.00	0.00	1.800
0.00	0.00	1.800	0.00	0.00	1.900	0.00	0.00	1.900
0.00	0.00	1.900	0.00	0.00	2.120	0.00	0.00	2.120
0.00	0.00	2.120	0.00	0.00	2.200	0.00	0.00	2.300
0.00	0.00	2.400	0.00	0.00	2.400	0.00	0.00	2.400
0.00	0.00	2.600	0.00	0.00	2.800	0.00	0.00	3.010
0.00	0.00	3.330	0.00	0.00	3.400	0.00	0.00	3.600
0.00	0.00	3.700	0.00	0.00	3.800	0.00	0.00	3.900
0.00	0.00	4.000	0.00	0.00	4.000	0.00	0.00	4.000
0.00	0.00	4.100	0.00	0.00	4.100	0.00	0.00	4.100
0.00	0.00	0.000	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 2.720
LOG AVE OF RATIOS = 0.40955
STANDARD DEVIATION = 0.976
95 PERCENT INTERVAL = 2.720 +/- 0.33

STATION SHAFT SHA 11 (DWP) DATE 12-23-70 RECORDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C	
0.00	0.00	1.300	0.00	0.00	1.500	0.00	0.00	1.540	
0.00	0.00	1.900	0.00	0.00	1.900	0.00	0.00	1.900	34
0.00	0.00	2.130	0.00	0.00	2.200	0.00	0.00	2.200	
0.00	0.00	2.300	0.00	0.00	2.400	0.00	0.00	2.600	32
0.00	0.00	2.600	0.00	0.00	2.600	0.00	0.00	2.720	
0.00	0.00	2.720	0.00	0.00	3.000	0.00	0.00	3.000	
0.00	0.00	3.200	0.00	0.00	3.200	0.00	0.00	3.200	
0.00	0.00	3.320	0.00	0.00	3.500	0.00	0.00	3.500	
0.00	0.00	3.600	0.00	0.00	3.700	0.00	0.00	3.700	
0.00	0.00	3.800	0.00	0.00	3.800	0.00	0.00	4.700	
0.00	0.00	5.350	0.00	0.00	5.400	0.00	0.00	7.550	—
0.00	0.00	9.980	0.00	0.00	0.000	0.00	0.00	0.000	

ARITH. AVE OF RATIOS = 3.294
LOG AVE OF RATIOS = 0.47423
STANDARD DEVIATION = 1.158
95 PERCENT INTERVAL = 3.294 +/- 0.38

STATION SHAFT SHA 10 (DWP) DATE 12-23-70 RECORDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C	
0.00	0.00	1.400	0.00	0.00	1.700	0.00	0.00	2.300	
0.00	0.00	2.610	0.00	0.00	2.830	0.00	0.00	2.830	39
0.00	0.00	3.000	0.00	0.00	3.000	0.00	0.00	3.000	
0.00	0.00	3.200	0.00	0.00	3.200	0.00	0.00	3.200	37
0.00	0.00	3.410	0.00	0.00	3.500	0.00	0.00	3.720	
0.00	0.00	3.720	0.00	0.00	4.100	0.00	0.00	4.200	36
0.00	0.00	4.300	0.00	0.00	4.400	0.00	0.00	4.400	
0.00	0.00	4.500	0.00	0.00	4.730	0.00	0.00	4.850	
0.00	0.00	5.320	0.00	0.00	5.400	0.00	0.00	5.400	
0.00	0.00	6.010	0.00	0.00	6.400	0.00	0.00	6.720	
0.00	0.00	6.720	0.00	0.00	6.720	0.00	0.00	6.980	
0.00	0.00	8.700	0.00	0.00	9.380	0.00	0.00	9.600	
0.00	0.00	9.980	0.00	0.00	13.400	0.00	0.00	0.000	
0.00	0.00	0.000	0.00	0.00	0.000	0.00	0.00	0.000	

ARITH. AVE OF RATIOS = 4.969
LOG AVE OF RATIOS = 0.64513
STANDARD DEVIATION = 1.679
95 PERCENT INTERVAL = 4.969 +/- 0.53

STATION SHAFT SHA 9 (DWP) DATE 12-23-70 RECORDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C	
0.00	0.00	1.900	0.00	0.00	2.300	0.00	0.00	2.500	
0.00	0.00	3.500	0.00	0.00	3.600	0.00	0.00	3.820	37
0.00	0.00	4.000	0.00	0.00	4.000	0.00	0.00	4.000	
0.00	0.00	4.000	0.00	0.00	4.300	0.00	0.00	4.700	35
0.00	0.00	5.000	0.00	0.00	5.000	0.00	0.00	5.000	
0.00	0.00	5.730	0.00	0.00	5.730	0.00	0.00	5.730	33
0.00	0.00	6.000	0.00	0.00	6.000	0.00	0.00	6.000	
0.00	0.00	6.340	0.00	0.00	6.340	0.00	0.00	7.000	
0.00	0.00	7.540	0.00	0.00	7.540	0.00	0.00	7.540	
0.00	0.00	9.150	0.00	0.00	9.550	0.00	0.00	10.010	
0.00	0.00	11.400	0.00	0.00	~~11.550~~	0.00	0.00	~~12.010~~	
0.00	0.00	15.500	0.00	0.00	28.500	0.00	0.00	43.400	
0.00	0.00	44.300	0.00	0.00	0.000	0.00	0.00	0.000	

ARITH. AVE OF RATIOS = 8.931
LOG AVE OF RATIOS = 0.81869
STANDARD DEVIATION = 2.594
95 PERCENT INTERVAL = 8.931 +/- 0.83

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
0.00	0.00	6.000	0.00	0.00	6.500	0.00	0.00	8.010
0.00	0.00	8.550	0.00	0.00	8.670	0.00	0.00	9.300
0.00	0.00	10.000	0.00	0.00	11.400	0.00	0.00	12.700
0.00	0.00	14.080	0.00	0.00	14.420	0.00	0.00	14.500
0.00	0.00	15.000	0.00	0.00	16.080	0.00	0.00	17.800
0.00	0.00	18.000	0.00	0.00	18.100	0.00	0.00	19.060
0.00	0.00	20.000	0.00	0.00	21.350	0.00	0.00	23.100
0.00	0.00	24.000	0.00	0.00	25.800	0.00	0.00	26.100
0.00	0.00	27.100	0.00	0.00	27.500	0.00	0.00	28.000
0.00	0.00	29.200	0.00	0.00	32.500	0.00	0.00	33.400
0.00	0.00	35.000	0.00	0.00	36.000	0.00	0.00	~~40.000~~
0.00	0.00	41.000	0.00	0.00	44.000	0.00	0.00	69.000
0.00	0.00	80.000	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 24.087
LOG AVE OF RATIOS = 1.30032
STANDARD DEVIATION = 5.511
95 PERCENT INTERVAL = 24.087 +/- 1.77

STATION SHALT SHA II (DWP) DATE 12-23-70 RECORDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
0.00	0.00	1.300	0.00	0.00	1.500	0.00	0.00	1.540
0.00	0.00	1.900	0.00	0.00	1.900	0.00	0.00	1.900
0.00	0.00	2.130	0.00	0.00	2.200	0.00	0.00	2.200
0.00	0.00	2.300	0.00	0.00	2.400	0.00	0.00	2.600
0.00	0.00	2.600	0.00	0.00	2.600	0.00	0.00	2.720
0.00	0.00	2.720	0.00	0.00	3.000	0.00	0.00	3.000
0.00	0.00	3.200	0.00	0.00	3.200	0.00	0.00	3.200
0.00	0.00	3.320	0.00	0.00	3.500	0.00	0.00	3.500
0.00	0.00	3.600	0.00	0.00	3.700	0.00	0.00	3.700
0.00	0.00	3.800	0.00	0.00	3.800	0.00	0.00	4.700
0.00	0.00	5.350	0.00	0.00	5.400	0.00	0.00	0.000
0.00	0.00	0.000	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 2.952
LOG AVE OF RATIOS = 0.44521
STANDARD DEVIATION = 1.062
95 PERCENT INTERVAL = 2.952 +/- 0.36

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
0.00	0.00	1.400	0.00	0.00	1.700	0.00	0.00	2.300
0.00	0.00	2.610	0.00	0.00	2.830	0.00	0.00	2.830
0.00	0.00	3.000	0.00	0.00	3.000	0.00	0.00	3.000
0.00	0.00	3.200	0.00	0.00	3.200	0.00	0.00	3.200
0.00	0.00	3.410	0.00	0.00	3.500	0.00	0.00	3.720
0.00	0.00	3.720	0.00	0.00	4.100	0.00	0.00	4.200
0.00	0.00	4.300	0.00	0.00	4.400	0.00	0.00	4.400
0.00	0.00	4.500	0.00	0.00	4.730	0.00	0.00	4.850
0.00	0.00	5.320	0.00	0.00	5.400	0.00	0.00	5.400
0.00	0.00	6.010	0.00	0.00	6.400	0.00	0.00	6.720
0.00	0.00	6.720	0.00	0.00	6.720	0.00	0.00	6.980
0.00	0.00	8.700	0.00	0.00	9.380	0.00	0.00	9.600
0.00	0.00	0.000	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 4.595
LOG AVE OF RATIOS = 0.62191
STANDARD DEVIATION = 1.582
95 PERCENT INTERVAL = 4.595 +/- 0.51

STATION SHAFT SHA 9 (DWP) DATE 12-23-70 RECORDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
0.00	0.00	1.900	0.00	0.00	2.300	0.00	0.00	2.500
0.00	0.00	3.500	0.00	0.00	3.600	0.00	0.00	3.820
0.00	0.00	4.000	0.00	0.00	4.000	0.00	0.00	4.000
0.00	0.00	4.000	0.00	0.00	4.300	0.00	0.00	4.700
0.00	0.00	5.000	0.00	0.00	5.000	0.00	0.00	5.000
0.00	0.00	5.730	0.00	0.00	5.730	0.00	0.00	5.730
0.00	0.00	6.000	0.00	0.00	6.000	0.00	0.00	6.000
0.00	0.00	6.340	0.00	0.00	6.340	0.00	0.00	7.000
0.00	0.00	7.540	0.00	0.00	7.540	0.00	0.00	7.540
0.00	0.00	9.150	0.00	0.00	9.550	0.00	0.00	10.010
0.00	0.00	11.400	0.00	0.00	11.550	0.00	0.00	12.010
0.00	0.00	15.500	0.00	0.00	28.500	0.00	0.00	0.000
0.00	0.00	0.000	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 6.936
LOG AVE OF RATIOS = 0.77165
STANDARD DEVIATION = 2.200
95 PERCENT INTERVAL = 6.936 +/- 0.72

STATION SHAFT SHA 7 (DWP) DATE 12-23-70 RECORDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
0.00	0.00	6.000	0.00	0.00	6.500	0.00	0.00	8.010
0.00	0.00	8.550	0.00	0.00	8.670	0.00	0.00	9.300
0.00	0.00	10.000	0.00	0.00	11.400	0.00	0.00	12.700
0.00	0.00	14.080	0.00	0.00	14.420	0.00	0.00	14.500
0.00	0.00	15.000	0.00	0.00	16.080	0.00	0.00	17.800
0.00	0.00	18.000	0.00	0.00	18.100	0.00	0.00	19.060
0.00	0.00	20.000	0.00	0.00	21.350	0.00	0.00	23.100
0.00	0.00	24.000	0.00	0.00	25.800	0.00	0.00	26.100
0.00	0.00	27.100	0.00	0.00	27.500	0.00	0.00	28.000
0.00	0.00	29.200	0.00	0.00	32.500	0.00	0.00	33.400
0.00	0.00	35.000	0.00	0.00	36.000	0.00	0.00	40.000
0.00	0.00	41.000	0.00	0.00	44.000	0.00	0.00	0.000
0.00	0.00	0.000	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 21.206
LOG AVE OF RATIOS = 1.26771
STANDARD DEVIATION = 5.095
95 PERCENT INTERVAL = 21.206 +/- 1.68

STATION SHAFT SHA 11 (DWP) DATE 12-23-70 RECORDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
0.00	0.00	1.300	0.00	0.00	1.500	0.00	0.00	1.540
0.00	0.00	1.900	0.00	0.00	1.900	0.00	0.00	1.900
0.00	0.00	2.130	0.00	0.00	2.200	0.00	0.00	2.200
0.00	0.00	2.300	0.00	0.00	2.400	0.00	0.00	2.600
0.00	0.00	2.600	0.00	0.00	2.600	0.00	0.00	2.720
0.00	0.00	2.720	0.00	0.00	3.000	0.00	0.00	3.000
0.00	0.00	3.200	0.00	0.00	3.200	0.00	0.00	3.200
0.00	0.00	3.320	0.00	0.00	3.500	0.00	0.00	3.500
0.00	0.00	3.600	0.00	0.00	3.700	0.00	0.00	3.700
0.00	0.00	3.800	0.00	0.00	3.800	0.00	0.00	4.700
0.00	0.00	0.000	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 2.790
LOG AVE OF RATIOS = 0.42620
STANDARD DEVIATION = 1.011
95 PERCENT INTERVAL = 2.790 +/- 0.36

STATION SHAFT SHA 10 (DWP) DATE 12-23-70 RECORDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
0.00	0.00	1.400	0.00	0.00	1.700	0.00	0.00	2.300
0.00	0.00	2.610	0.00	0.00	2.830	0.00	0.00	2.830
0.00	0.00	3.000	0.00	0.00	3.000	0.00	0.00	3.000
0.00	0.00	3.200	0.00	0.00	3.200	0.00	0.00	3.200
0.00	0.00	3.410	0.00	0.00	3.500	0.00	0.00	3.720
0.00	0.00	3.720	0.00	0.00	4.100	0.00	0.00	4.200
0.00	0.00	4.300	0.00	0.00	4.400	0.00	0.00	4.400
0.00	0.00	4.500	0.00	0.00	4.730	0.00	0.00	4.850
0.00	0.00	5.320	0.00	0.00	5.400	0.00	0.00	5.400
0.00	0.00	6.010	0.00	0.00	6.400	0.00	0.00	6.720
0.00	0.00	6.720	0.00	0.00	6.720	0.00	0.00	6.980
0.00	0.00	8.700	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 4.307
LOG AVE OF RATIOS = 0.60101
STANDARD DEVIATION = 1.504
95 PERCENT INTERVAL = 4.307 +/- 0.50

STATION SHAFT SHA 9 (DWP) DATE 12-23-70 RECORDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
0.00	0.00	1.900	0.00	0.00	2.300	0.00	0.00	2.500
0.00	0.00	3.500	0.00	0.00	3.600	0.00	0.00	3.820
0.00	0.00	4.000	0.00	0.00	4.000	0.00	0.00	4.000
0.00	0.00	4.000	0.00	0.00	4.300	0.00	0.00	4.700
0.00	0.00	5.000	0.00	0.00	5.000	0.00	0.00	5.000
0.00	0.00	5.730	0.00	0.00	5.730	0.00	0.00	5.730
0.00	0.00	6.000	0.00	0.00	6.000	0.00	0.00	6.000
0.00	0.00	6.340	0.00	0.00	6.340	0.00	0.00	7.000
0.00	0.00	7.540	0.00	0.00	7.540	0.00	0.00	7.540
0.00	0.00	9.150	0.00	0.00	9.550	0.00	0.00	10.010
0.00	0.00	11.400	0.00	0.00	11.550	0.00	0.00	12.010
0.00	0.00	0.000	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 6.023
LOG AVE OF RATIOS = 0.73826
STANDARD DEVIATION = 1.996
95 PERCENT INTERVAL = 6.023 +/- 0.68

STATION SHAFT SHA 7 (DWP) DATE 12-23-70 RECORDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
0.00	0.00	6.000	0.00	0.00	6.500	0.00	0.00	8.010
0.00	0.00	8.550	0.00	0.00	8.670	0.00	0.00	9.300
0.00	0.00	10.000	0.00	0.00	11.400	0.00	0.00	12.700
0.00	0.00	14.080	0.00	0.00	14.420	0.00	0.00	14.500
0.00	0.00	15.000	0.00	0.00	16.080	0.00	0.00	17.800
0.00	0.00	18.000	0.00	0.00	18.100	0.00	0.00	19.060
0.00	0.00	20.000	0.00	0.00	21.350	0.00	0.00	23.100
0.00	0.00	24.000	0.00	0.00	25.800	0.00	0.00	26.100
0.00	0.00	27.100	0.00	0.00	27.500	0.00	0.00	28.000
0.00	0.00	29.200	0.00	0.00	32.500	0.00	0.00	33.400
0.00	0.00	35.000	0.00	0.00	36.000	0.00	0.00	40.000
0.00	0.00	0.000	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 19.915
LOG AVE OF RATIOS = 1.24587
STANDARD DEVIATION = 4.892
95 PERCENT INTERVAL = 19.915 +/- 1.66

STATION SHAFT SHA 10 (DWP) DATE 12-23-70 RECORDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
0.00	0.00	1.400	0.00	0.00	1.700	0.00	0.00	2.300
0.00	0.00	2.610	0.00	0.00	2.830	0.00	0.00	2.830
0.00	0.00	3.000	0.00	0.00	3.000	0.00	0.00	3.000
0.00	0.00	3.200	0.00	0.00	3.200	0.00	0.00	3.200
0.00	0.00	3.410	0.00	0.00	3.500	0.00	0.00	3.720
0.00	0.00	3.720	0.00	0.00	4.100	0.00	0.00	4.200
0.00	0.00	4.300	0.00	0.00	4.400	0.00	0.00	4.400
0.00	0.00	4.500	0.00	0.00	4.730	0.00	0.00	4.850
0.00	0.00	5.320	0.00	0.00	5.400	0.00	0.00	5.400
0.00	0.00	6.010	0.00	0.00	6.400	0.00	0.00	6.720
0.00	0.00	6.720	0.00	0.00	6.720	0.00	0.00	6.980
0.00	0.00	0.000	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 4.174
LOG AVE OF RATIOS = 0.59075
STANDARD DEVIATION = 1.467
95 PERCENT INTERVAL = 4.174 +/- 0.50

STATION SHAFT SHA 9 (DWP) DATE 12-23-70 RECORDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
0.00	0.00	1.900	0.00	0.00	2.300	0.00	0.00	2.500
0.00	0.00	3.500	0.00	0.00	3.600	0.00	0.00	3.820
0.00	0.00	4.000	0.00	0.00	4.000	0.00	0.00	4.000
0.00	0.00	4.000	0.00	0.00	4.300	0.00	0.00	4.700
0.00	0.00	5.000	0.00	0.00	5.000	0.00	0.00	5.000
0.00	0.00	5.730	0.00	0.00	5.730	0.00	0.00	5.730
0.00	0.00	6.000	0.00	0.00	6.000	0.00	0.00	6.000
0.00	0.00	6.340	0.00	0.00	6.340	0.00	0.00	7.000
0.00	0.00	7.540	0.00	0.00	7.540	0.00	0.00	7.540
0.00	0.00	9.150	0.00	0.00	9.550	0.00	0.00	10.010
0.00	0.00	11.400	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 5.652
LOG AVE OF RATIOS = 0.71679
STANDARD DEVIATION = 1.903
95 PERCENT INTERVAL = 5.652 +/- 0.66

STATION SHAFT SHA 7 (DWP) DATE 12-23-70 RECORDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
0.00	0.00	6.000	0.00	0.00	6.500	0.00	0.00	8.010
0.00	0.00	8.550	0.00	0.00	8.670	0.00	0.00	9.300
0.00	0.00	10.000	0.00	0.00	11.400	0.00	0.00	12.700
0.00	0.00	14.080	0.00	0.00	14.420	0.00	0.00	14.500
0.00	0.00	15.000	0.00	0.00	16.080	0.00	0.00	17.800
0.00	0.00	18.000	0.00	0.00	18.100	0.00	0.00	19.060
0.00	0.00	20.000	0.00	0.00	21.350	0.00	0.00	23.100
0.00	0.00	24.000	0.00	0.00	25.800	0.00	0.00	26.100
0.00	0.00	27.100	0.00	0.00	27.500	0.00	0.00	28.000
0.00	0.00	29.200	0.00	0.00	32.500	0.00	0.00	33.400
0.00	0.00	35.000	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 18.749
LOG AVE OF RATIOS = 1.22437
STANDARD DEVIATION = 4.703
95 PERCENT INTERVAL = 18.749 +/- 1.65

STATION SHAFT SHA 9 (DWP) DATE 12-23-70 RECORDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
0.00	0.00	1.900	0.00	0.00	2.300	0.00	0.00	2.500
0.00	0.00	3.500	0.00	0.00	3.600	0.00	0.00	3.820
0.00	0.00	4.000	0.00	0.00	4.000	0.00	0.00	4.000
0.00	0.00	4.000	0.00	0.00	4.300	0.00	0.00	4.700
0.00	0.00	5.000	0.00	0.00	5.000	0.00	0.00	5.000
0.00	0.00	5.730	0.00	0.00	5.730	0.00	0.00	5.730
0.00	0.00	6.000	0.00	0.00	6.000	0.00	0.00	6.000
0.00	0.00	6.340	0.00	0.00	6.340	0.00	0.00	7.000
0.00	0.00	7.540	0.00	0.00	7.540	0.00	0.00	7.540
0.00	0.00	9.150	0.00	0.00	9.550	0.00	0.00	10.010
0.00	0.00	0.000	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 5.460
LOG AVE OF RATIOS = 0.70545
STANDARD DEVIATION = 1.854
95 PERCENT INTERVAL = 5.460 +/- 0.66

STATION SHAFT SHA 7 (DWP) DATE 12-23-70 RECORDER GEORGE BARNETT

LENGTH = A
HEIGHT = B
FLATNESS RATIO = C

A	B	C	A	B	C	A	B	C
0.00	0.00	6.000	0.00	0.00	6.500	0.00	0.00	8.010
0.00	0.00	8.550	0.00	0.00	8.670	0.00	0.00	9.300
0.00	0.00	10.000	0.00	0.00	11.400	0.00	0.00	12.700
0.00	0.00	14.080	0.00	0.00	14.420	0.00	0.00	14.500
0.00	0.00	15.000	0.00	0.00	16.080	0.00	0.00	17.800
0.00	0.00	18.000	0.00	0.00	18.100	0.00	0.00	19.060
0.00	0.00	20.000	0.00	0.00	21.350	0.00	0.00	23.100
0.00	0.00	24.000	0.00	0.00	25.800	0.00	0.00	26.100
0.00	0.00	27.100	0.00	0.00	27.500	0.00	0.00	28.000
0.00	0.00	29.200	0.00	0.00	32.500	0.00	0.00	0.000
0.00	0.00	0.000	0.00	0.00	0.000	0.00	0.00	0.000

ARITH. AVE OF RATIOS = 17.683
LOG AVE OF RATIOS = 1.20302
STANDARD DEVIATION = 4.526
95 PERCENT INTERVAL = 17.683 +/- 1.64

TAB

APPENDIX E

Plate 4.--Partial geologic map of the Superior quadrangle, Arizona. Pre-volcanic and post-volcanic rocks generalized; dacitic ash flows partly divided into zones.

TO ACCOMPANY REPORT
APPENDIX A
DATED 4/20/71
BY T. S. BARNETT

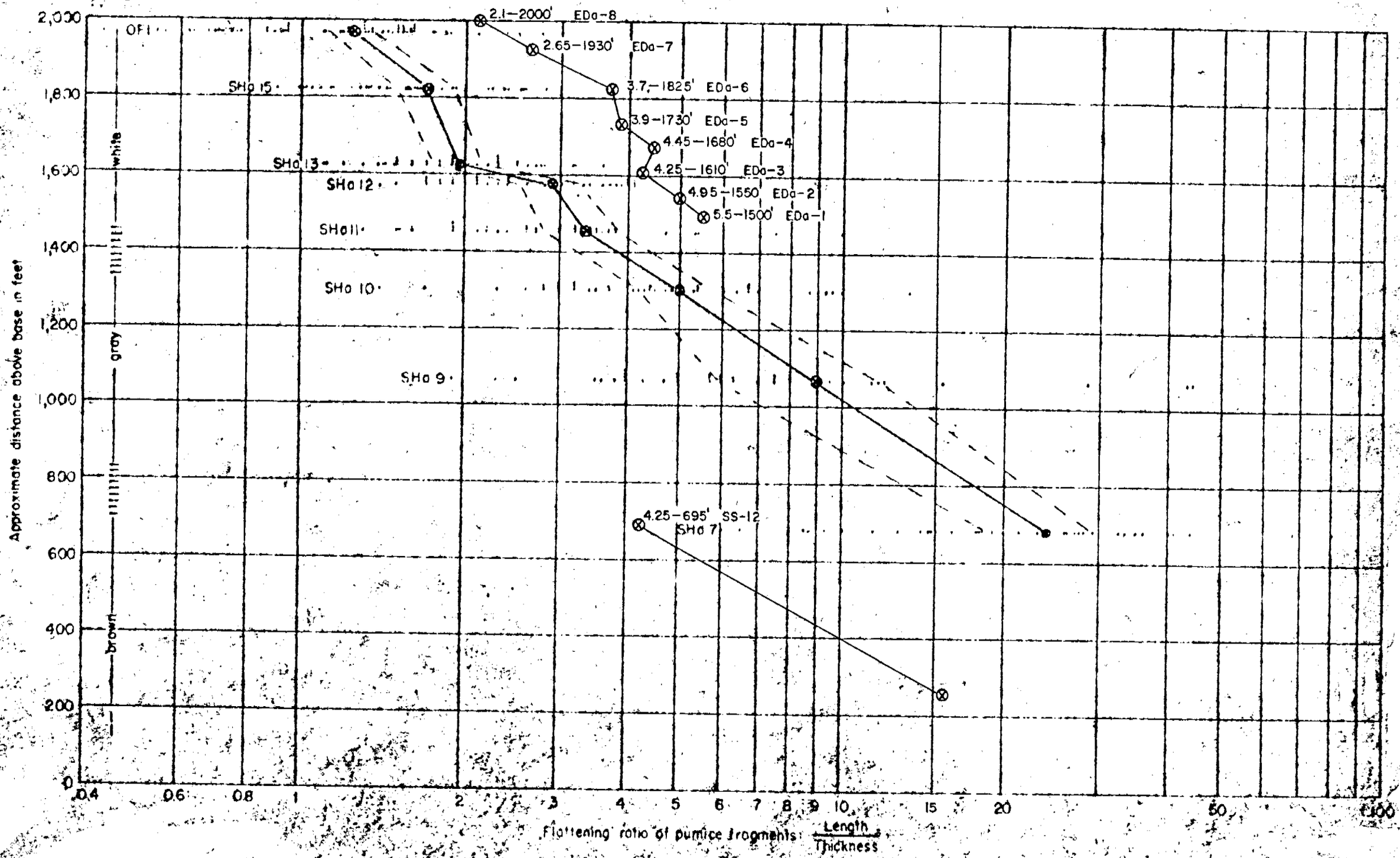

Plate 2. Relation between the flattening ratio of pumice fragments and the distance above the base. The average flattening ratio is shown by a solid line, 95% confidence limits are shown by dashed lines, and individual fragments by dots.

TABLE OF CONTENTS FOR SUPERIOR EAST STUDIES

Summary Report

Attachment A (Map #2427) Structural blocks and Premineral Elev.
Attachment B (Map #2435 a & b, x-sections)

Addenda A (Report on Pumice Flattening Ratios, Thickness Estimates and Zonal Variations in Dacite)

Attachment C (Map #2428) Pumice ratio stations and zones
Attachment D Unchanged copy of D. W. P.'s Plate 4
Appendix A Arizona Geol. Soc. Guide Book III article
Appendix B Individual(s) ratio measurements
Appendix C Combined ratio determinations
Appendix D D. W. P.'s ratio data less deletions
Appendix E Modified copy of Plate 2, D. W. P.'s thesis
Figure 1 (In text)
Table 1 Pumice ratio lists and depth calculations
Table 2 Summary of ratios and depths

Addenda B (Report on Structure(s)

Attachment A (Map #2427) same as above for reference
Attachment B (Map #2435 a & b) same as above for reference
Attachment C (Map 2428) same as above for reference
Attachment E (Map 2451) Plot of known and photo-interpreted structures in the dacite and adjacent areas
Table 3 (In text) Interpreted drill logs
Appendix F Structures and their importance (in portions of the Haunted Canyon, Superior, Inspiration, Pinal Ranch and Globe Quadrangles) for the N45-55° ± 10°E system

Addenda C

Attachment F
Appendix G

LIST OF REPORTS, ATTACHMENTS, APPENDICES, ETC.
FOR THE SUPERIOR EAST PROJECT

	Title	Subject	Where Found
Reports:	Summary of Superior East Project, Dacite Studies	Summary of Studies	Report to W.E.S. 4-14-71
	Addenda A	Superior dacite, pumice flattening ratios, thickness estimates and zones	Report to J.D.S. 4-20-71
	Addenda B	Lineaments and Structures Study - Superior Dacite	Report to J.D.S. 4-26-71
	Addenda C	Geologic Study of Globe-Superior Dist. and Region, plus notes	Report to J.D.S. 5-21-71
Attachments:	A, (Map #2427 + sepia topo overlay)	Interpreted Structural Blocks and elevation of Premineral rock units	Accompanies Summary Report and Addenda B
	B (Map #2435 a&b)	Interpreted Cross-sections for Superior Project Area	Summary Report and Addenda B
	C (Map #2428)	Pumice Ratio Studies, Zonal variations, structures, modified after Plate 4 D.W.P.'s thesis	Addenda A
	D	Superior Dacite Studies-Unmodified copy of Plate 4, D.W.P.'s thesis	Addenda A

	Title	Subject	Where Found
Attachment	E (Map #2451)	Known Structure(s) and Photo-Interpreted Lineaments, Superior Dacite	Addenda B
	F (Map #2452)	Regional Geologic Map, 1:250,000scale	Addenda C
Appendix:	A	D.W.P.'s article in Ariz. Geol. Soc. Guide-book III	Addenda A
	B	Individual's pumice ratio measurements, uncorrected (part 1) and corrected (part 2) data	Addenda A
	C	Combined readings & pumice ratios un-corrected (part 1) and corrected (part 2) data	Addenda A
	D	Ratio Calculations and Calculations Less deletions, data by D.W.P. (Summary given first)	Addenda A
	E	Condensed Copy of Plate 2 from D.W.P.'s thesis, showing ratio changes with depth	Addenda A
	F	Structures in Haunted Canyon and other quadrangles	Addenda B
	G	Work sheets and notes pertaining to district and/or regional study	Addenda C

	Title	Subject	Where Found
Table:	1	Calculated dacite thicknesses and pumice ratios	Addenda A p.p. 6-9
	2	Summary of ASARCO dacite data	Addenda A p.p. 10-12
	3	Interpreted Drill Logs	Addenda B p.p. 3-5
Figure:	1	Plot of Pumice Ratios and zones for Superior dacite vs. height above base of dacite.	Addenda A

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona

April 26, 1971

TO: J. D. Sell

FROM: G. S. Barnett

Re: A REPORT ON THE INTERPRETATION OF LINEAMENTS AND STRUCTURE(S) FOR THE APACHE LEAF TUFF, "DACITE", SUPERIOR EAST PROJECT

ADDENDA B

The study of structures within the main dacite mass from Superior to Sutton's Summit (west to east) and from Haunted Canyon to north of Ray (from north to south) was conducted in order to extend previously mapped structures and to map any structure(s) that had not been recognized previously. Areas immediately adjacent to the dacite were studied to determine if any direct correlations might be made between structures exposed adjacent to the main mass and known or inferred structures within the dacite. In addition, the entire region or Globe-Superior District was studied to determine if a sequence or pattern of faulting on a district-wide or regional basis could be found.

The controls and/or relative subsequent displacements associated with structures in the dacite must of necessity rely upon an analysis of adjacent areas (especially) and regional studies as well. Also, models or hypotheses of formation for structure(s) from world-wide studies were compared to those in the dacite and pre-dacite rocks. The previously extant structure patterns are believed to be the single most important factor in ore search and localization or in the reconstruction of a geological-structural history for an area. Therefore, I have searched widely for examples which I believe are analogous to the structures found in and beneath the dacite.

Within the main dacite mass and adjacent areas, color photographs were used as an aid in the delimiting and plotting of all features which might be indicative of a fault trace or zone. The results of this study are shown as Attachment E (Attachment A is a map accompanying my summary report to Mr. W. E. Saegart, April 14, 1971). This data was mapped on a 1:24000 scale ($7\frac{1}{2}$' Quad.) base. The lineaments are represented by lines which were then color-coded according to their relative strength of expression and/or inferred importance. Red lines are those lineaments which were interpreted to be most directly related to major or important structures. These were often expressed as saddles, continuous fractures, drainages, color changes, linear zones of small fractures, etc., etc. Purple was used for features that were not as strongly expressed as the first group, but judged according to the same criteria. Blue was used for the most inferential and/or least well

expressed lineaments which were nevertheless thought to be significant. Although the mixing of observation and inference was avoided as much as possible, there are numerous instances where designations are interpretive. The relative importance of a structure or structures may or may not be directly related to its strength of expression. Therefore, my map can only serve as a guide or framework into which the inferred structure and history of the dacite or subsurface may be referred.

Within the main dacite mass, zonal variations, pumice fragments (ratio of length to width) and structure studies have been completed by D. W. Peterson as part of his U.S.G.S. mapping in the Superior 7½' Quadrangle and also as part of his doctoral thesis at Stanford University (1). Planar structures in the dacite were mapped by Peterson. These are thought by me to be relatively undistrubed flowage planes which have sometimes been affected by later faulting with the apparent steepening of many dips. Initial dips within the dacite probably vary from zero in the central portions of the main mass to up to 45°+ on the margins (verified? by drilling in dacite southwest and west of Power's Gulch). Dips and strikes were found to vary widely in very short distances, but as gross characterizations, dip and strike symbols were found to be generally reliable. Dr. Peterson's published works represent the first extensive study of the "Dacite", and his mapping is included, with modifications by me, as Attachment C submitted with Addenda A (Report on Pumice Ration, Dacite Depths, etc. to Mr. James D. Sell, April 20, 1971), and included for reference purposes with this report as are Attachemnts A and B.

The readily observable relations as; strongly expressed faults, abrupt color changes, pumice fragment plattening, etc., have been adequately discussed in his dissertation and as part of his U.S.G.S. mapping. A generalized discussion and mapping by Peterson were also included as Appendix A in Addenda A.

My own work indicates that numerous additional lineaments are present. These I interpreted to be fault sets and grouped into systems. Those faults mapped by me often had indeterminate displacements. No real order, sequence or relative significance was evident to me upon termination of my study. The reasons for this included the fact that faults displacing the same rock type or units and often obscured either by soil cover or by a very strongly developed joint set in the dacite, were extremely difficult to analyze. With this in mind, I conducted a study of structure(s) in the region to attempt to find a pattern or system of fracturing. Ultimately, this lead to a determination of structural events which I believe are significant with respect to mineralization localization and a more correct understanding of its controls.

Table one represents my interpretation of drill hole logs for drill holes in the Dacite. These were used as an aid in determining significance of faulting in the Dacite and also as an indicator of pre-Dacite rock unit occurrences and/or depths.

TABLE THREE

DRILL HOLE	DESIGNATION	COMPANY
No. 1	(DCA-1) Haunted Canyon	Miami Copper/ Superior Oil

DEPTHS (in Ft.)	UNITS	THICKNESS (in Ft.)
0 - 550	dacite	550' (tuff?)
550 - 1020	dirty white felsite (dacite tuff?)	470'
1020 - 1785	Tev (Earlier volcanics)	765'
1785 - 2210	Andesite (Basaltic andesite?)	465'
2210 - 3040	Whitetail Conglomerate (volcanic fragments?)	830'
3040 - 4011.5	Whitetail Conglomerate (sedimentary clasts)	971.5
4011.5	TOTAL DEPTH	

DRILL HOLE	DESIGNATION	COMPANY
No. 2	(DCA-2) Pinal Ranch North	Miami Copper/ Superior Oil

DEPTHS (in Ft.)	UNITS	THICKNESS (in Ft.)
0 - 1095	dacite? dacite	1095'
1095 - 1270	dacite? rhyolite?(dacite tuff unit?)	175'
1270 - 1471 (initial stopping point)	Whitetail Conglomerate	255' - 265'
1471 - 1525 (+10'?)	Whitetail Conglomerate	
1525 (+ 10'?) - 1772	Pinal Schist, Schultze granite, and gneiss. 0.05-0.10 Cu	
1471	TOTAL DEPTH (INITIALLY)	
1772	TOTAL DEPTH (FINAL)	

DRILL HOLE	DESIGNATION	COMPANY
No. 3	(DCA-3) Pinal Ranch South	Miami Copper, Superior Oil

DEPTHS (in Ft.)		UNITS		THICKNESS (in Ft.)
0 - 1400	dacite	dacite	1490'	1400'
1400 - 1415		vitrophyre		15'
1415 - 1490		dacite tuff		75'
1490 - 2430		basalt or basaltic andesite		940'
2430 - 3000		Whitetail Conglomerate		570'
3000		TOTAL DEPTH		

DRILL HOLE	DESGINATION	COMPANY
I	Devil's Canyon (I.C.C.C.)	Inspiration Consolidated Copper Co.

DEPTHS (in Ft.)		UNITS		THICKNESS (in Ft.)
0-- 1025	dacite	dacite	1086'	1025'
1025 - 1086		vitrophyre & tuff		61'
1086 - 2939		Whitetail Conglomerate (db, sch, md)		1853'
2939 - 3475		Pinal Schist & Diabase (barren, unaltered, broken)		536'
3475		TOTAL DEPTH		

DRILL HOLE	DESIGNATION	COMPANY
OF-1A	(Oak Flat North)	Kerr-McGee

DEPTHS (in Ft.)		UNITS		THICKNESS (in Ft.)
0 - 1635	Dacite	dacite	1790'	1635'
1635 - 1670		vitrophyre		35'
1670 - 1790		dacite tuff (Earlier volcanics?)		120'
1790 - 1995		Earlier volcanics?		205'
1995 - 2050		Volcanic? Conglomerate		55'

(continued)

DEPTHS (in Ft.)	UNITS	THICKNESS (in Ft.)
2050 - 2150	basaltic andesite	100'
2150	TOTAL DEPTH	

DRILL HOLE	DESIGNATION	COMPANY
DC-1	(Devil's Canyon)	Kerr-McGee

DEPTHS (in Ft.)		UNITS		THICKNESS (in Ft.)
0 - 1130		dacite		1130'
1130 - 1160	Dacite	vitrophyre	1165'	30'
1160 - 1165		tuff		5'
1165 - 2303		Whitetail Conglomerate		1138'
2303		TOTAL DEPTH		

DRILL HOLE	DESIGNATION	COMPANY
M-1	(M-1)	Continental Materials

DEPTHS (in Ft.)		UNITS		THICKNESS (in Ft.)
0 - 1800		dacite		1800'
1800 - 1830	Dacite	vitrophyre	1890'	30'
1830 - 1890		tuff		60'
1890 - 1900		tuffaceous? conglomerate		10'
1900 - 2402		basaltic andesite		502'

I found it convenient to group structures (faults) into eight systems. Although the structures studied were usually faults, there were additional structures; synclines, anticlines, blocks, dip, strikes, etc., which were utilized to determine the proper groupings into systems. An extensive review was also conducted of the literature to attempt to determine the most accurate description or delimitation for systems which might be present, as well as, their ages and/or significance.

The systems chosen were:

1) N 75° W ± 10°
2) N 30° W ± 15°
3) N - S
4) N 30° E ± 10°
5) N 50° E ± 10°
6) N 60° E
7) N 70° E ± 10°
8) E - W

Although this can be interpreted as being little more than a listing including nearly the entire span of compass directions, depending on orientation, I have concluded that this is usuable and necessary to characterize faults in the Globe-Superior District, especially with reference to the fault network in the dacite and subsurface. I formed these systems after their applicability was tested within the area and also by comparison to trend determinations in adjacent districts and world-wide. In particular, I relied heavily upon the works of P. C. Badgely, M. P. Billings, Moody and Hill, and E. D. Wilson in setting up these systems.

The dacite mass does not lend itself readily to this type of classification, in that, post-dacite faulting apparently does not have comparable displacements as adjacent areas with rather complex settings. The dacite has not been faulted to the extent that adjacent areas, such as the Globe Valley or Superior Basin, have been. However, displacements on the order of 250+ feet have occurred in the dacite along north-south trending faults. Evidence of low-angle faulting in the main dacite mass has not been found by me. Yet, thrusting is of great significance in the Globe District (on the Globe Hills and Globe Valley structural blocks), where Older Precambrian Madera Diorite overlies dacite and Whitetail Conglomerate.

I am confident that the faulting pattern extant in pre-mineral rocks and the mechanisms for their formation are valid and utilizable to

interpret the pattern of faulting found in the dacite. Additionally, this analysis can be used to interpret the depths to pre-mineral rocks underneath the dacite. Although sufficient controls are not present to provide an "accurate" depth determination, the basement configuration can be at least approximated as was done in Attachment A (Report to W. E. Saegart, April 16, 1971). This analysis will be of greater value when additional controls (drill hole data) become available, as an aid in determining relative fault movements and their significance.

The following is a general discussion of the control(s) and nature of each system, as understood by me. The systems have had a long history and some reorientation has surely occurred; there is also the great probability that at different times the stress orientations have been sufficiently different to cause a lower order (weaker or less well expressed) direction to become primary or very strong at a later date.

The N75°W ±10° system (those faults whose trend are in this range) is thought to be a control for igneous activity and ultimately of mineralization. This is probably an en echelon system of fractures with generally left lateral slip. Rotational movements have caused this system to appear right lateral after erosion stripped tilted blocks on either side of the fault(s). This has been a continuously active zone which probably reached a high point in significance at peak tectonic periods. For convience, I will refer to these periods as the Larimide, Early mid-Tertiary, Late mid-Tertiary and Pasadenan. This system has been recognized to be of great significance in the Mineral Mt. area, Ray, Mineral Butte, Pinal Ranch Quadrangle, west of Superior and in the Powers Gulch-Carlota area. In the dacite, elements of this system include the Conley Springs fault and those faults to the north and south having this trend. This zone represents a predominantly slip-strike set which has deformed or controlled all rock units encountered as; in the Pinal Schist it is evident in foliation changes; in the diabase the system acted as an available conduit; the Paleozoics are brecciated, etc. The system in post-Larimide, probably both mid-Tertiary and Pasadenan, time has served as a breaking or tearing system across which major displacements have occurred with greater dip-slip components evident, as: Cactus-Carlota Kelly Fault Zone, the Conley Fault, a fault north and west of Hutton Peak, etc.

The N30°W ±15° system is a major adjustment zone with rotational and/or translational displacements of blocks or units. This trend was tensional in nature in Larimide times with infilling of Schultze Granite and subsequent mineralization occurring in the Miami to Sutton's Summit area. This trend of hypogene - early mineralization can be expected to continue underneath the dacite. Mid-Tertiary faulting along this zone, as well as Larimide faulting, occurred as both major high-angle faulting and high-angle faulting along numerous smaller faults whose combined displacements are very large (on the order of 1000+ feet). The mid-Tertiary faulting in this system served as basin or uplifted block terminations. This had a consequent control on Whitetail and/or Earlier Volcanic accumulations.

The very largest displacements on this zone have occurred in post-dacite, Pasadenan ($10x10^6$ M.Y. to Recent) times.

The N-S $\pm 15^\circ$ (north-south) system is known to be the latest active fault system and has a "step-fault" pattern in the dacite. This system is the most well expressed in the dacite and has been mapped in part by D. W. Peterson. These faults may be generally described as a series of step-faults across which the dacite and underlying units have been progressively down-dropped inward towards a low area or graben trending N-S in the vicinity of Devils Canyon. This system has often had a major displacement propogated along either the N-30°W or N30°E systems as is evidenced in what has been sometimes termed the Basin and Range trend (N30°W), and in the district by local displacements on the Miami Fault. The southern part of the Concentrator Fault, the west branch of the Gold Gulch Fault (near Castle Dome, and the broader Pinto Creek Fault zone well expressed to the south in the Ray vicinity and north from the junction of Haunted Canyon and Pinto Creek are in this system. The major displacements now evident in this zone may well be not as significant as pre-dacite movements, this is evident from the controls of Whitetail deposition it has exerted and also by the weaker expression near the center of the dacite of this zone when compared to areas north or south. However, this system has effected what are locally very important displacements and regionally even larger ones. Evidence for a pre and post-dacite age for this system is found in the north-south trend to the dacite and Whitetail Conglomerate "syncline". The axis of this "syncline in Tertiary units" is thought to be along the trace of Devils Canyon. Asymmetry of this structure is indicated from calculated and drilled dacite depths. The dacite apparently is thicker on the west limb and gradually thins to the east and west from this axis.

Over 1000 feet of Whitetail Conglomerate is exposed north of Ray; 1138+ feet are indicated in drill hole DC-1; 1801+ feet of conglomerate(s)? were intercepted in drill hole DCA-1. This accumulation of Whitetail Conglomerate and/or a Volcanic conglomerate (to the north) has been labeled by me as a Tertiary Trough in Attachment A. The N-S faulting has down-dropped dacite in the Ray vicinity and in areas adjacent to the main mass (west of Magma Mine). This system of faults have had lateral or strike-slip displacements in the Magma Mine area where they are left-lateral. From the Magma Mine area to the east these faults generally have the east side up, this is evidenced also both by the Older Precambrian rocks exposed east of the dacite and by a gradual thinning of the dacite to the east of Devils Canyon.

The N30°E $\pm 15^\circ$ fault system has had recurrent movements along some segments up to very recent times - (West Branch of the Gold Gulch Fault, near Miami on the Miami Fault, in the Powers Gulch-Grizzly Mnt. faulted area, etc.) - but, the greatest displacement along this system apparently occurred previous to the extrusion of the main dacite mass with the consequent formation of a "block trough". This trough probably trends approximately N30°E and underlies the northwest portion of the main dacite mass. This break is not well expressed in the dacite and the faulting is only occasionally well expressed in surrounding areas. However, the dacite mass does show a "break in topography or

or relief" with this trend from the Powers Gulch Area in the Haunted Canyon Quadrangle, to the southwesterly turn in the Queen Creek drainage. Drill hole data supports a block trough designation as evidenced by drill holes DCA-1, OF-1A and M-1. DCA-2 and OF-1A had intercepts of Earlier Volcanics immediately underlying the dacite. M-1, as logged by me, contained no rhyolitic or glassy fragments from the upper Earlier Volcanics. A basalt or basaltic andesite was encountered in these holes however, which I consider as subdividable from the Earlier Volcanics; either as a Lower Earlier Volcanic unit or as an independent rock formation. These three drill holes, the outcrop pattern for Earlier Volcanic units (on the northwest side of the dacite) and a field examination in the Haunted Canyon area, suggest that this may well be described as a block trough with the northeast corner of the trough or block downdropped relative to the other corners. A significant amount of tilting is evidenced by the dips of units within the Earlier Volcanics as well as by the dips found in portions of the dacite mass. Significant (830? feet in DCA-1) amounts of a conglomerate, tentatively labeled as volcanic conglomerate to differentiate it from Whitetail Conglomerate (containing? volcanic fragments) may have accumulated in this trough.

The N30°W system has been largely overprinted or obscured by later N-S faulting, but Hugh Olmstead noted an important conduit afforded by this system (either along a portion of or parallel to the Miami Fault) for the strongest hypogene mineralization in the Miami-Inspiration ore bodies.

The N50°E ±10° system can be found to vary in strength and trend, however, it trends most often N45-55°E. This system includes the Sleeping Beauty fault zone and numerous others. It also is the trend for the linearly controlled intrusives in areas adjacent to the dacite such as the Manitou Granite, the Willow Springs Granodiorite and Lost Gulch Quartz Monzonite. I considered this trend to be strong and of sufficient importance to conduct an extensive analysis of published maps of the area and at least briefly describe those elements I felt were most important in this system. This analysis is included as Appendix F, this report (Appendices A-E were included with Addenda A report to J. D. Sell, April 20, 1971).

The N60°E system may actually be considered as either a subsystem to the N50°E ±10° or the the N70°E ±10° systems. The importance of this trend in the published descriptions of the Christmas, Ray, San Manuel, Copper Creek and other districts lead me to consider this as a separate system. This system of fractures has served as a conduit for mineralizing fluids and as a locus for mineralization in areas adjacent to the dacite (Miami-Inspiration, Castle Dome, Copper Cities, Diamond H, Globe Veins) and in all probability should also serve as such beneath the dacite. The long axis of the Schultze Granite also has approximately this trend. To the northeast of the dacite the localization of the Miami-Inspiration, Live Oak, Miami East and other deposits around a nose or lobe of the Schultze Granite may represent the intersection of this long axis or zone with the northeast "corner" of a block, now represented by the Pinal Mountains. The southwesterly

projection of this axis, which may also represent the "tear" or major break of a northwesterly trending Pinal Mountains Block (N30°W trend?), should again encounter the northwest "corner" or structural setting underneath dacite cover; and there, may also have allowed the formation of a lobe or nose in the Schultze Granite. From such considerations, plus the projection of the Silver King intrusive complex and Superior mineralization trends, I have concluded that the highest probability for ore-grade mineralization occurring will be found at or near drill hole M-1 or drill site CE-2. Possibilities for a larger deposit or group of deposits "wrapped" around a rather narrow nose or lobe in this vicinity (substantially as indicated by J. D. Sell on his "Generalized Geologic Map for the Superior East Project", ASARCO map no. 2271) are excellent. The lobe(s) of the Schultze Granite will probably be similar to those encountered to the east northeast and as such, will probably be smaller than the projected nose area shown on Sell's map. However, insufficient subsurface data is presently available to indicate exactly where this lobe or others will be located.

The N70°E ±10° system is most important as a locus for Granite Porphyry intrusions. The small difference in trend between this trend and the N60°E trend of strongest mineralization, or other conduits and/or sites for mineralization, is considered valid and of great significance. The small angle difference often found between major structures and secondary-tertiary auxiliary strains is found both on the mega and micro scales. I do not have an adequate explanation for these angular relations (labeled "oblique trends" by me) between major and minor fracture systems. I believe, however, that this may be the result of reoriented stresses and strains in the manner indicated by Moody and Hill (G.S.A. Bull, Vol. 67, pp. 1207-1246).

The E-W system of faulting is not very strong in the dacite. It is the trend of the Magma Vein and numerous other veins and/or faults in the Superior area and has played an important part in the structural deformation of the region. This system is considered by me to be a "complementary" fracture direction, complementary to the N-S ±15° system. It too probably represents a direction of "tensional release", i.e. of normal faulting. As with all these systems, deformation along them has taken place along previously extant faulting planes; as such, displacements are either taken up by numerous smaller faults and/or available faults in other systems (especially? N75°W ±10° or N30°W ±10° as high angle displacements, i.e. normal and less often reverse faulting).

Only a slight reorientation of 10-15° would cause one to classify faults in this system, or any other, in another group. However, this does not appear to have occurred except very locally. This reorientation is significant for structures of a Precambrian age but is not considered significant (except at the local scale) in the Laramide or Pasadenan.

My recommendations for further work on and/or use of this data are included, in part, in Addenda A. The maps prepared (Attachments A, B, and C) are usable to give preliminary drill cost estimates and also

to select drill sites. I would suggest, if it has not already been done, that drill sites be selected on the "shallower" or up side of faulted units even if these do not immediately overlie the area of interest. In this manner, drilling monies will be spent less quickly and a large amount of economic-geological information will be made available. I would also suggest that the configuration chosen eventually give a grid pattern although not necessarily drilled in a set or predetermined sequence. A case in point is DCA-2 which was drilled near an area indicated by Peterson's mapping to have a thinner dacite cover. A "step" sequence of drilling may also serve to check those interpretations made to date without having to drill the deeper areas unless favorable indications (alteration, mineralization, etc.) point in that direction. Down hole I.P. and/or other geophysical methods should be run to render additional data from single drill holes.

George S. Barnett

George S. Barnett

GSB:sh

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TAB

Appendix F

Note on Method

My delineation of all major zones begins in the uppermost portion of the map (North for North-South, NE for Northeasterlies; NW for Northwesterlies). I began noting them from the west edge of the maps to the east.

Because the area had previously been mapped, I correlated my photo-geologic study to their fault traces. At times my fracture-plots were not exactly in line with those faults plotted on the ground. In these instances, I substituted those mapped for my own.

STRUCTURES AND THEIR IMPORTANCE - HAUNTED CANYON QUAD.

Major Structures and/or Their Indication

The Kennedy fault must be considered the most prominent fault in the quadrangle. Along a major portion of this fault, all post-Ruin Granite and Diabase (younger than R.Gr.) units have been removed by uplift and subsequent erosion. Younger Precambrian units are exposed to the southeast of this fault, with progressively younger units exposed to the southeast until one encounters the Pinal schist, and diabase in Power's Gulch. Therefore, the suggestion is that a southeastern limit to the Pinto Creek structural block must be located north and east of Power's Gulch. I would suggest that this boundary or boundaring structure is represented by the northwest contact of the Dacite and Earlier Volcanics and well expressed where Haunted Canyon turns from a southeasterly course to a northeasterly one; soon thereafter Haunted Canyon junctions with Pinto Creek. Pinto Creek probably represents a major zone of N-S faulting in the dacite plateau and along the eastern edge of the dacite. Devil's Canyon may well be a reflection of this N-S trend.

(Pinal Mts. as center point to arcuate zone of mineralization of greatest significance?)

To the NE in the vicinity of Horrell Creek the Kennedy fault is offset by a structure or structures trending approximately N 40 W. A N-S Horst block of pCds and pCm is exposed in Qtg in the NE portion of the quadrangle.

NAME: Kennedy Fault

DIRECTION: Northwest corner Haunted Canyon Quad. Forming boundary between Ruin Granite to the northwest and younger rocks to the southeast.

SIGNIFICANCE: The Kennedy Fault represents a major fault separating the Campaign Creek Block to the northwest from the Kennedy Ranch Block to the southeast. No Paleozoics are shown northwest of this fault. Nor are the major bodies of diabase shown to the southeast present. The abundant outcrops of Rgr shown in the northeast portion of the block, across the Kennedy Fault, indicate a southwesterly dip. However, the progressively younger formations exposed to the southeast indicate that the southeasterly dip of the formations and/or blocks is of much greater importance.

AGE: Precambrian - only by comparison to parallel trends.

Laramide - None evident.

Tertiary - The Kennedy Fault appears to cut the Haunted Canyon Caldera and displace earlier Volcanic units. This would place the age of the Kennedy Fault within the last 20 MY, i.e., probably Quaternary rather than Tertiary. The fact that the Haunted Canyon Caldera limits turn into this fault, suggest that it was also pre-caldera, in part.

SPECIAL NOTES:

NAME: North East J K Mnt. N 110° 57'30"

DIRECTION: N-50 E

LOCATION: Scanlon Tunnel to Barnes Tunnel. Horrel Ranch. West Pinto Creek to House Rock Spring, S.E. of Government Hill.

SIGNIFICANCE: Possible locus for db-rgr contact to N.E., Apache Group to S.E. No Paleozoics. Devore Wash probably parallel bounding structure. Cut off by West branch Gold Gulch Fault. Whitetail affected by N.E. trending faults along S.W. line from Horrell Ranch. Not an affector of dacite.

AGE: Pre-Cambrian - db-rgr contact locus

Tertiary - qmp-Tev contact; No Whitetail to S.W. of Kennedy Ranch Road; minor outcrops of Tw do occur to N.E. Whitetail faulted to E.N.E. Nothing readily apparent in Td or Tev?

SPECIAL NOTES:

NAME: Devore Wash

DIRECTION: N - 50E

LOCATION: A major drainage in Granite Basin; multiple parallel faults to N.W.; Middle Haunted Canyon, S.E. of Ripper Spring.

SIGNIFICANCE: Forms db-sch contact and elongation; Forms S.E. edge Haunted Canyon Caldera; major parallel faults also in area, some homoclinal or monoclinal? flexturing in Tony Ranch area.

AGE: Pre-Cambrian - db - localization of sch-db contact

Post-Pliocene = 20 M.Y. Post dacite faulting, forming Sc. boundary of Haunted Canyon Caldera.

SPECIAL NOTES:

NAME: Lower Haunted Canyon Zone.

DIRECTION: N 47°E (May be N49°-50°E)

LOCATION: White Tank Sp.; Webster Mnt. (S.E.), Lower Haunted Canyon, Laramide? Felsite of Silver King area.

SIGNIFICANCE: Forms repeating Paleozoic section N.E. of Ruin Basin. Partial control of Gerald Wash flowing into Ruin Basin. Controls (?) northern contact of Td and Pre-volcanic units, generally. Forms Lost Gulch qm-db and Pioneer contact. Probably N-Easter running into the west branch of Gold Gulch Fault. S.W. dp (between Pinto and Powers Gulch) controlled by it? Lower portion of Haunted Canyon localized by it? Td-Tev contact. Tev and Paleozoics contact. Felsite localizer, as well as some contacts of qd in Silver King area. Pod of qd, N.E. of main qd mass, also along it.

AGE: Probably Pre-Cambrian as with parallel set. Some Laramide(?) activity as in felsite and qd locus, as well as Lost Gulch qm. Tertiary activity appears minimal although probably evidenced by N.E. fault trend into West Gold Gulch fault.

SPECIAL NOTES:

NAME: Siphon and Myberg Basin Zone

DIRECTION: N-40E

LOCATION: Siphon Basin to Myberg Basin, Continental Tunnel, Duquesne Spring, Grissly Mnt., Powers Gulch Pb-Zn veins and Sch-Tertiary Volcanics contact. Portions of Tev-Td contact. Middle part of Silver King Wash.

SIGNIFICANCE: S.E. terminus of Ruin Basin, locus for Ruin-Diabase contact; Silver Bell shaft. Martin-Escabrosa repeat of section. Not expressed in Td Flat Top Mt. Paleozoics S.W. side of Granite Basin show little evidence although complex faulting pattern probably represents it. Juniper Flat may show some evidence - canyon cutting. Escabrosa and Martin at Continental Tunnel. N.W. limit to Castle Dome ore body? Abundant faulting in Gold Gulch. Also abundant faulting N. N.E. of Grizzly Mt. Turning of Kelly Fault zone may be evidence of control also. Pb-Zn veins in sch and db parallel trend. May be slightly expressed in Tev-Td contact - northwest of section 15 and 16. Silver King mine and related intrusive are slightly east of zone (may be reflecting more N.E. intersections with zone). "Middle" portion of Silver King Wash seems localized by this zone.

AGE: Pre-Cambrian - by comparison to other parallel zones and rgr-db contact.

Laramide control may be exemplified by Silver Bell, Continental and Silver King deposits.

SPECIAL NOTES:

NAME: Sleeping Beauty fault zone.

DIRECTION: N 52° E (Olmstead = N 55° E; N.P. Peterson = N 60° E)

LOCATION: Sleeping Beauty fault, N. of Day Peaks, Manitou Hill?, Town of Superior.

SIGNIFICANCE: Locus for db-lgm contact. Termination of gp. Parallel structures west of Copper Cities mine. North of Day Peaks (Td) examplified by abundant faulting in Me-Dm-lgm relations overturned bedding, etc. Trace appears jostled in Castle Dome Area but W.S.gd. lies along trace as well as PC M.gr. Swede Vein and Schultze Granite outcrops may reflect control of this zone. No obvious controls were expressed in Superior area.

AGE: Pre-Cambrian localizer of PC.M.gr. - sch contact

Laramide - lgm-db contact localizer; lgm and Willow Springs granite locus.

Tertiary - Minor, fractures W of Copper Cities.

SPECIAL NOTES:

NAME: Jewel Hill - Money Metal zone

DIRECTION: N 45° E

LOCATION: S.W. in section 31, N.E. of Sleeping Beauty Peak. Money Metal shaft, Jewel Hill, Carlota Mine, Kings Crown.

SIGNIFICANCE: N and E of Sleeping Beauty Peak, forms repeating of Me section, dp adjacent to zone WNW of Sleeping Beauty Peak. Money Metal shaft vein along it. Nothing readily apparent in Potato Patch area. gp in Jewel Hill area at intersection of E NE zone with N 45 E zone. gd in Castle Dome area also transverse to it. Sch-lgm contact localized along it. The Pinto Shaft, if shifted to the NW (rocks change from Paleozoic to Pre-Cambrian in Kelly Fault zone), would lie along this zone along with Carlota Mine. Numerous mapped faults in db. Black Bess shaft proper is also lying in this zone. The majority of the dacite plateau show little expression of this zone. Where the zone is projected to exit from under the plateau to the E NE of the Apex Mine, a NW trend is much more predominent. The terminus for these NW as well as the repetition of dacite may reflect this trend.

AGE: Pre-Cambrian - suggested by db - Apache Group contact.

Laramide - dp N.NW of Sleeping Beauty Peak - Castle Dome ore body Carlota, Pinto and Black Bess shafts.

SPECIAL NOTES: Superior Deposit said to be localized in gentle syncline. Peterson also notes synclinal folding south of King's Crown. These synclines plunge to the east. Jewel Hill NE of Castle Dome show a definite synclinal structure with an indeterminate plunge, trending N 50° E. The NW limb is bounded by db and consists of PC ps?, Dm, Me, Pn; Tw in center. The SE limb is also bounded by db and consists of PCds, Dm, Me, Pn with gp covered by Tw in center.

NAME: Inspiration zone

DIRECTION: N 52° E

LOCATION: N and NW of Moonshine Hill, Needle Mnt., N. Pinal Ranch, Queen Creek Mine.

SIGNIFICANCE: Defiance Vein, Vanadium. Relatively indistinct in Inspiration area. I suggest that later fracturing and movements obliterated most portions of the zone. I also suggest that the Inspiration "Block" must be shifted northwestward with possible some rotation to allow a more close relationship to become evident. Webster Gulch may reflect a control by this zone. In the Live Oak shaft area, the Barney Fault turns from a N-S course to a N.E. direction. Bronx Vein locus? The Tb, Sch-Tsg contact north of Pinal Ranch (a more fundamental N to N NE trend of the contact). The lower portion of Iron Canyon lies NW of this zone but does parallel it. The Queen Creek Mine has a series of overturned units in the Pn.

AGE: Pre-Cambrian - Suggested only by comparison to parallel grain traced previously.

Laramide - evidence weak, Bronx Vein System; Tb, Sch, and Sgr contacts. More NEasterly trend to faults in the vicinity of Queen Creek Mine and south.

Tertiary - Dacite is involved in some of the faulting in the Barney fault area.

NAME: Miami Zone

DIRECTION: N 53° E

LOCATION: South of Ramboz Peak, Town of Miami, Hutton Peak, Belmont Mine.

SIGNIFICANCE: Ramboz Peak is in the upper portion of the "Globe Hills" block as described by N.P. Peterson (13th N.M.G.S. 1962). I would suggest that the Globe Hills block be reated as a separate entity with regard to an analysis of structure, although a very close similarity of trend and occurrence is indicative of a possible common origin for fractures, I suspect shifting has occurred along major slip-strike or oblique faults (striking N 30° W and Right- lateral?) North of Claypool - Miami probably forms Bloody Tanks drainage. The Sch-sgr contact and Sch occurrences are probably relatable to this zone. In vicinity of Schultze Ranch, Sch again outcrops, Bloody Tanks wash also turns. The sch-sgr contact NE of Five Point Mnt. is probably also localized by this zone. The American Mine and veins North of the Mercer adit also lie along this zone. It is also possible that the stream south of Hutton Peak is an expression of this zone, although the projection passes directly under Hutton Peak. A few streams on the Plateau seem to turn to parallel this zone although no major fracture patterns were recognized by me in my mapping. The north-easterly trending fractures in the Belmont Mine area. The Concentrator Fault takes a pronounced turn to the S.E. along this zone also.

AGE: Pre-Cambrian - evidence lacking except by comparison to other trends.

Laramide - probably localizer for Schultze-sch contact near Miami and to the S.W. Mercer Adit, American Mine, Belmont.

Tertiary - Probably as underlying locus for Bloody Tanks Wash, Schultze Ranch Basin, Drainages on dacite plateau and turn in Concentrator Fault.

SPECIAL NOTES: The faulting - north of the Mercer Adit; in the vicinity of the American Mine; West of Hutton Peak; East of Devil's Canyon (GQ 818); in the Oak Flat area; in the Queen Creek Mine area and south to Belmont Canyon, may represent a series of en echelon faults with the east relatively side up.

NAME: Pinal Mountains and South

DIRECTION: N 55° E

LOCATION: Southeast edge of Globe Hills Block (?), Pinal Mountains, Northwest corner Section 4, Mineral Creek, 6000' West-northwest of Hagen Rch.

SIGNIFICANCE: May form repetition of Td and Miss. Escabrosa south of Lea tunnels. Tgp southwest of Pinal Mountains probably lies long this zone. Numerous veins lie along this zone parallel to the Tgp occurrences. TheApache Group and diabase is also exposed southeast of this trend.

AGE: Precambrian - by comparison to other trends and Pinal Schist foliation(s).

Larimide - T. Granite Porphyry

Tertiary - Gila Conglomerate drainage

SPECIAL NOTES: The Samsel vein and other notheast trending fractures are very much the predominant structural trends in the Pinal Mountains region. Drainages in the Pinal Schist trend in this direction as well as foliation. It is also of note that possibly as much as 80% of the foliations dip to the northwest. These N 45° - 55° trends continue and seem to control drainage in the Gila Conglomerate also.

NAME: Jones Ranch - South Miami

DIRECTION: N 53° E

LOCATION: Irene Fault area, Jones Ranch, S.E. of Alfred Springs, Pasquale Vein, N.E. corner section 19 T 2S, R 12 E.

SIGNIFICANCE : Zonal Control of most veins in Globe Hills block evident although this may be a shifted block. Irene Vein, Mineral Farms, New Dominion may be evidence of this zone. Poorly, if at all, expressed in Td of Globe Hills block or Qtg valley fill. May have formed contact for Solitude, Sch-Schultze Granite contacts. Pasquale Vein parallel to sub-parallel to this zone. Drainages across dacite plateau seem to follow this trend from Miami zone to the NW, to Jones Ranch - South Miami zone. Series of faults south of Pacific Canyon probably represent control by this zone. Penn. Naco is also outcropping well into dacite along this zone.

AGE: Pre-Cambrian - evidence minor

Laramide - locus for Irene vein? New Dominion, Solitude granite, Pasquale Vein, faulting on west side of dacite probably related to this period.

Tertiary:- drainage control in plateau and Pn outcrops into dacite.

NAME: Ellis Vein - Black Rock Mine

DIRECTION: N 50° E

LOCATION: 4000' Southeast of Ellis-Henderson Ranches zone. Globe-Dominion Shaft, Ellis Vein, Red Rock Mine.

SIGNIFICANCE: Probably locus for Old Dominion workings and associated veins. Possible locus for northeast trend of Madera-Schist contact adjacent to Ellis vein. Tertiary granite-porphyry also probably localized by zone. Red Rock Mine and Cole and Goodwin Mines also lie on the projection of this zone. The lyons Canyon drainage also lies along this trend. The dacite does not exhibit any features suggesting a northeast break along this zone. However, to the southwest Tertiary Whitetail outcrops--dacite may be localized by this zone.

AGE: Precambrian - pCmd - Pinal Schist outcrops.

Laramide - Tertiary Granite Porphyry dikes localization. Vein system in Globe Hills Block. Veins of Black Rock and Red Rock Mines.

Tertiary - None very apparent.

SPECIAL NOTES:

NAME: Ellis-Henderson Rch

DIRECTION: N 50° E

LOCATION: William Shaft, Old Dominion, north of Ellis Rch., Northeast corner, Section 11, T 2 D, R 13 E.

SIGNIFICANCE: Possible relation to Old Dominion-Williams shaft, etc., Madera-Schist contact probably localized by this zone. Small squirt of Tgp near Henderson Rch. Veins southwest of Ellis Rch. probably localized by this zone as are Tgp dikes. Qtg. appears offset along this line and some streams on the plateau seem to be localized along this zone. More Whitetail is exposed to the southwest.

AGE: Precambrian - control of Madera-Schist contact.

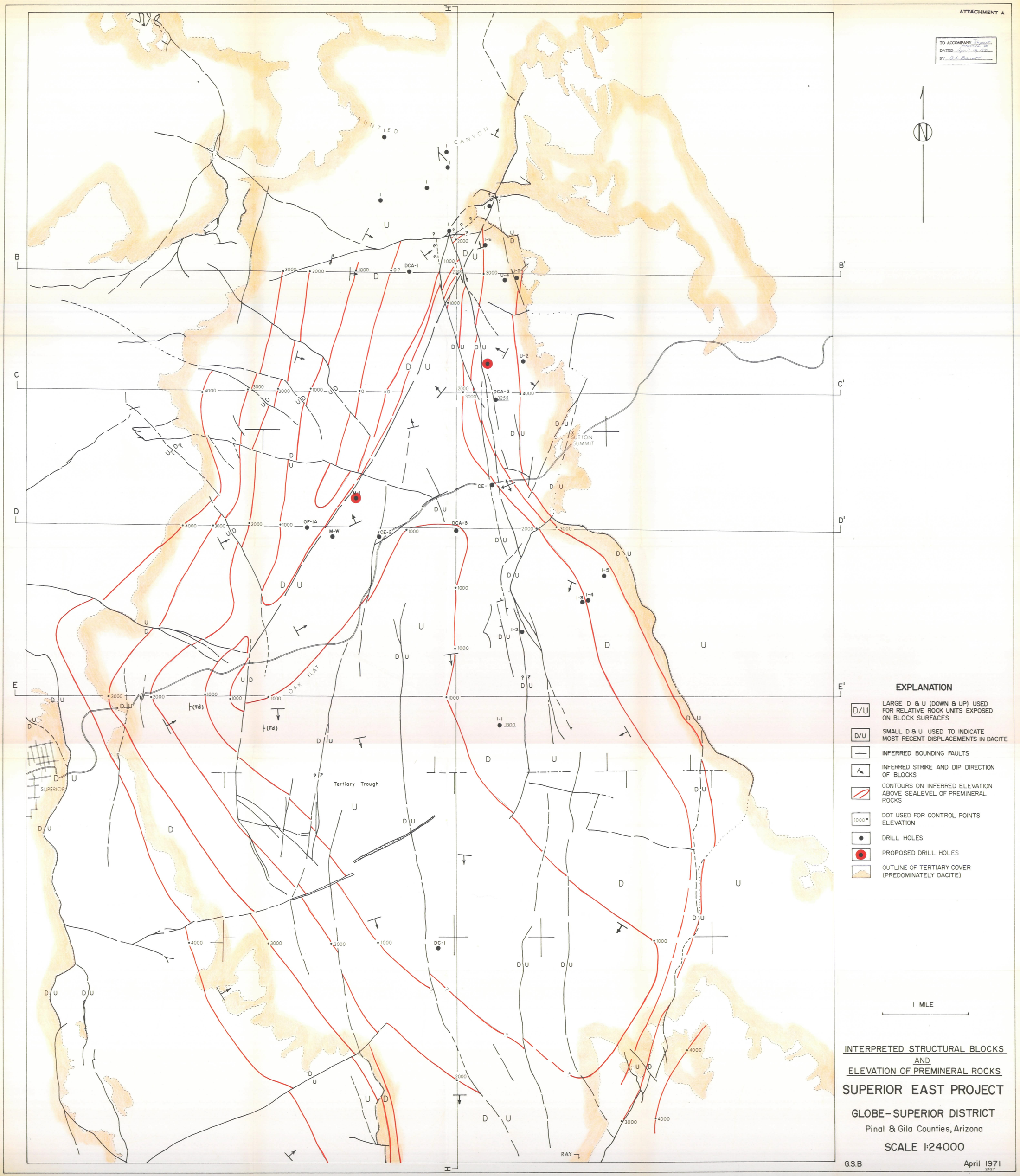
Laramide - Old Dominion, Tgp, Williams Shaft.

Tertiary - Secondary control of Whitetail and Gila outcrops.

SPECIAL NOTES:

ATTACHMENT A

TO ACCOMPANY Report Addendum B
DATED April 14, 1971
BY G.S. Barrett



INTERPRETED STRUCTURAL BLOCKS
AND
ELEVATION OF PREMINERAL ROCKS

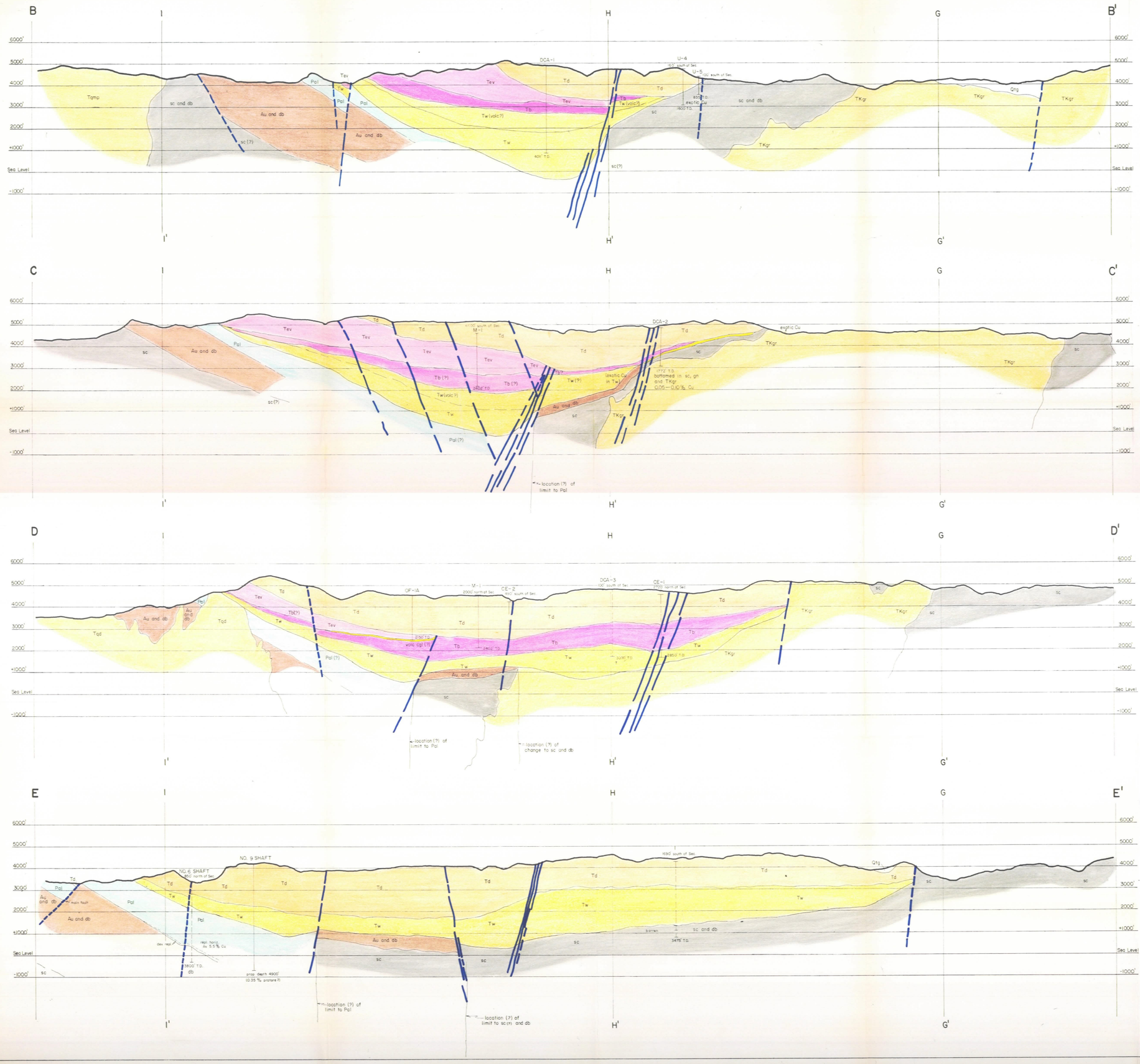
SUPERIOR EAST PROJECT

GLOBE-SUPERIOR DISTRICT
Pinal & Gila Counties, Arizona

SCALE 1:24000

G.S.B April 1971

ATTACHMENT B



EAST, WEST SECTIONS

(looking north)

SUPERIOR EAST PROJECT

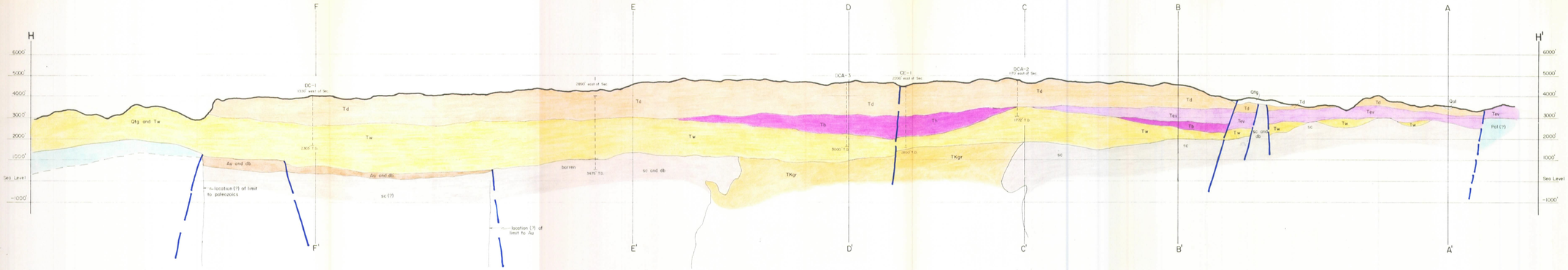
Pinal County, Arizona

SCALE: 1" = 2000'

G.S.B. APRIL, 1971

2435a

ATTACHMENT B



EXPLANATION

QUATERNARY

- Qtg — Gila conglomerate

TERTIARY

- Td — Dacite (20 m.y.)
- Tev — Earlier volcanics (rhyolites, latites, glasses, vent units, etc.)
- Tvc — Volcanic conglomerate (weathered surface(s) or tuffaceous conglomerates)
- Tb — Basalt or basaltic andesite (previously not differentiated from Tev)
- Tw — Whitetail conglomerate (includes some Tvc units)

LARAMIDE

- TKgr — Schultze granite (63.5 m.y.) and other intrusives (Tqmz, Tqt)

PALEOZOIC

- Pal — Sedimentary rocks

YOUNGER PRECAMBRIAN

- db — Diabase (1140 m.y.)
- Au — Apache group

OLDER PRECAMBRIAN

- sc — Pinal schist

Inferred locations for major rock type changes

Faults

MODIFIED AFTER J.D. SELL, JUNE 1970

TO ACCOMPANY REPORT
DATED APRIL 14, 1971
BY G. S. BARNETT

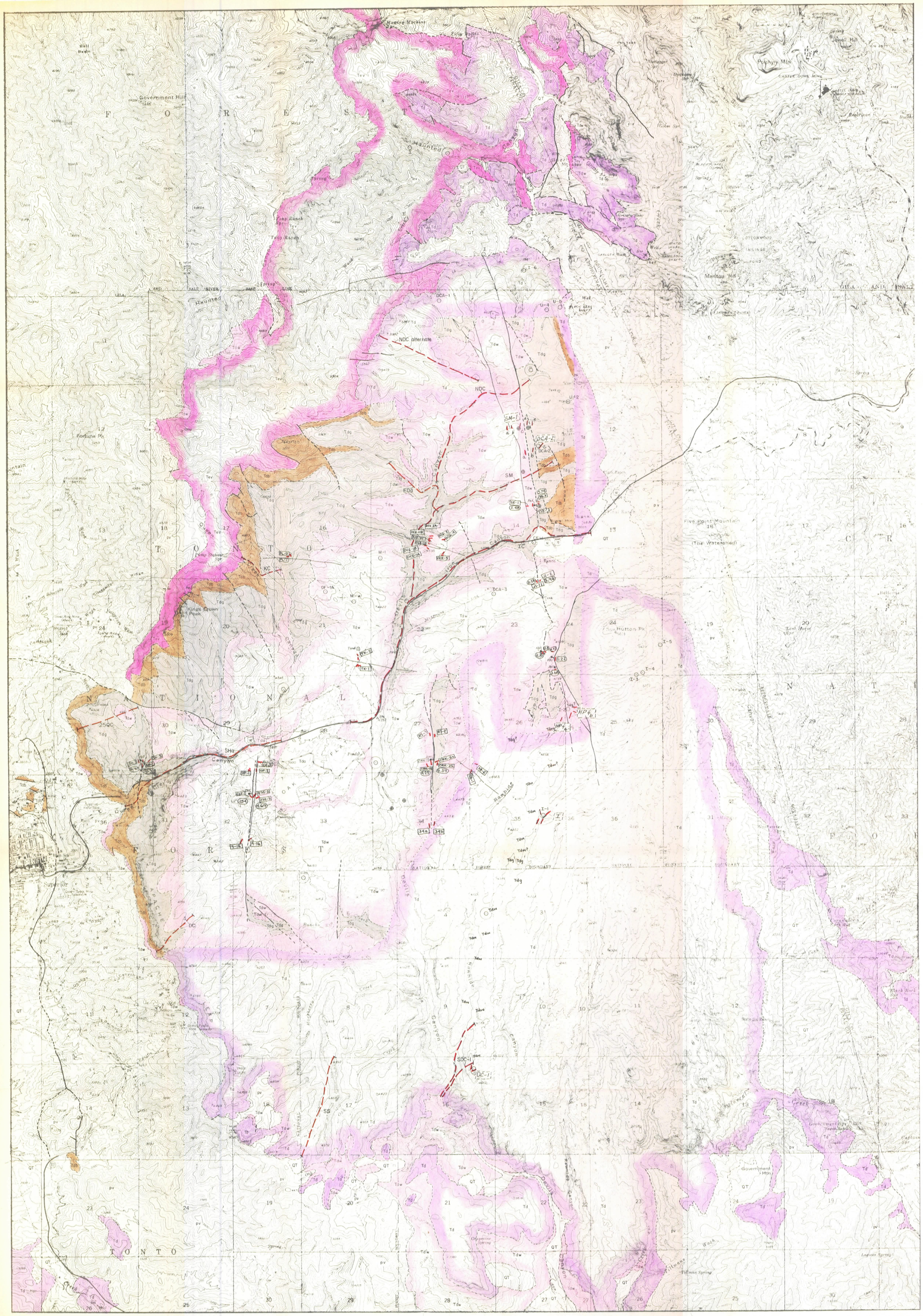
NORTH, SOUTH SECTION
(looking west)

SUPERIOR EAST PROJECT
Pinal County, Arizona

SCALE: 1" = 2000'

G.S.B. April, 1971

2435 b



68B

ATTACHMENT C

F O R E S T
Government Hill
Haunted
T O N T O
N A T I O N A L
Kings Crown Peak
Five Point Mountain
(The Watershed)
Hutton Pk
Superior
Porphyry Mtn
Menitau Hill
CASTLE DOME MINE
NDC alternate
NDC
SM
EDa
KC
DC
SS
SDC-1
Td
Tdw
Tdg
Tdb
Tev
QT
pv
N A T
F O R
C R

EXPLANATION

QT	Post-volcanic rocks; principally Gila conglomerate and alluvium
Td Tda Tdw Tdg Tdb	Dacitic ash flows: Tdb—basal tuff, vitrophyre and brown zone; Tdg—gray zone; Tdw—white zone; Tda—air-fall tuff; Td—undivided
Tev	Earlier volcanic rocks; mostly rhyolite and obsidian flows, tuffs, and tuff breccias
pv	Pre-volcanic rocks; metamorphic, sedimentary, and igneous rocks
⊕	Horizontal planar structure
5.74	Average flattening ratio of pumice fragments on opposite sides of fault
235-1	Average flattening ratio of pumice fragments on opposite sides of fault by G.S.B.
HP4a	Proposed station (a—west of fault, b—east of fault)
SS	Approximate location of profiles
EDa	Proposed profile location
	Fault; dashed where approximately located
360	Number of feet of vertical separation on fault. Symbol on downthrown side

MODIFIED AFTER D.W. PETERSON, 1958-1960.

N

Pumice Ratio Stations
and
Dacite Zones

SUPERIOR EAST PROJECT

GLOBE-SUPERIOR DISTRICT

Pinal & Gila Counties, Arizona

SCALE 1:24000

G.S.B.
April, 1971

ATTACHMENT E

N

EXPLANATION

COLOR-CODED ASARCO MAPPING

Strength of Expression

- STRONG
- MODERATE
- WEAK

- U.S.G.S MAPPING

- High-angle fault (dot and/or D on down-thrown side with calculated throw shown near dot)
- SLIP-STRIKE FAULT
- JOINT PATTERN

ROCK UNITS

- Qtg GILA CONGLOMERATE
- Td DACITE
- Tev EARLIER VOLCANICS
  - Tevi vents

TO ACCOMPANY.....
DATED.....
BY.....

KNOWN STRUCTURES & PHOTO-INTERPRETED LINEAMENTS
SUPERIOR EAST PROJECT

PINAL & GILA COUNTIES ARIZ.

SCALE 1:24,000

G.S.B

Mar. 1971

2451

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Attachment B (Map #2435 a & b, x-sections)

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Attachment C (Map #2428) Pumice ratio stations and zones
Attachment D Unchanged copy of D. W. P.'s Plate 4
Appendix A Arizona Geol. Soc. Guide Book III article
Appendix B Individual(s) ratio measurements
Appendix C Combined ratio determinations
Appendix D D. W. P.'s ratio data less deletions
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Figure 1 (In text)
Table 1 Pumice ratio lists and depth calculations
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Addenda B (Report on Structure(s)

Attachment A (Map #2427) same as above for reference
Attachment B (Map #2435 a & b) same as above for reference
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Attachment E (Map 2451) Plot of known and photo-interpreted structures in the dacite and adjacent areas
Table 3 (In text) Interpreted drill logs
Appendix F Structures and their importance (in portions of the Haunted Canyon, Superior, Inspiration, Pinal Ranch and Globe Quadrangles) for the N45-55° ± 10°E system

Addenda C

Attachment F
Appendix G

LIST OF REPORTS, ATTACHMENTS, APPENDICES, ETC.
FOR THE SUPERIOR EAST PROJECT

	Title	Subject	Where Found
Reports:	Summary of Superior East Project, Dacite Studies	Summary of Studies	Report to W.E.S. 4-14-71
	Addenda A	Superior dacite, pumice flattening ratios, thickness estimates and zones	Report to J.D.S. 4-20-71
	Addenda B	Lineaments and Structures Study - Superior Dacite	Report to J.D.S. 4-26-71
	Addenda C	Geologic Study of Globe-Superior Dist. and Region, plus notes	Report to J.D.S. 5-21-71
Attachments:	A, (Map #2427 + sepia topo overlay)	Interpreted Structural Blocks and elevation of Premineral rock units	Accompanies Summary Report and Addenda B
	B (Map #2435 a&b)	Interpreted Cross-sections for Superior Project Area	Summary Report and Addenda B
	C (Map #2428)	Pumice Ratio Studies, Zonal variations, structures, modified after Plate 4 D.W.P.'s thesis	Addenda A
	D	Superior Dacite Studies-Unmodified copy of Plate 4, D.W.P.'s thesis	Addenda A

	Title	Subject	Where Found
Attachment	E (Map #2451)	Known Structure(s) and Photo-Interpreted Lineaments, Superior Dacite	Addenda B
	F (Map #2452)	Regional Geologic Map, 1:250,000scale	Addenda C
Appendix:	A	D.W.P.'s article in Ariz. Geol. Soc. Guide-book III	Addenda A
	B	Individual's pumice ratio measurements, uncorrected (part 1) and corrected (part 2) data	Addenda A
	C	Combined readings & pumice ratios un-corrected (part 1) and corrected (part 2) data	Addenda A
	D	Ratio Calculations and Calculations Less deletions, data by D.W.P. (Summary given first)	Addenda A
	E	Condensed Copy of Plate 2 from D.W.P.'s thesis, showing ratio changes with depth	Addenda A
	F	Structures in Haunted Canyon and other quadrangles	Addenda B
	G	Work sheets and notes pertaining to district and/or regional study	Addenda C

	Title	Subject	Where Found
Table:	1	Calculated dacite thicknesses and pumice ratios	Addenda A p.p. 6-9
	2	Summary of ASARCO dacite data	Addenda A p.p. 10-12
	3	Interpreted Drill Logs	Addenda B p.p. 3-5
Figure:	1	Plot of Pumice Ratios and zones for Superior dacite vs. height above base of dacite.	Addenda A

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona

May 26, 1971

TO: J. D. Sell

FROM: G. S. Barnett

NOTES ON THE REGIONAL GEOLOGY
OF THE GLOBE-SUPERIOR DISTRICT
AND ADJACENT AREAS

ADDENDA C

The general geology, structure and geologic history of the Globe-Superior region have been described in numerous publications, however, a reinterpretation of some data, relating to the region, and/or the offering of a few working hypotheses seems warranted. I have studied numerous geologic features and reports for the area and believe that some data have been misinterpreted; also, I have collected sufficient data to compile a map at 1:250,000 scale for the region (submitted as Attachment F, this report). A recapitulation of the geologic history of the region is a necessary step in order to provide a framework into which structure, tectonism and mineralization may be related.

I must preface my discussion of the regional geology with the observation that the interpretation(s) offered in many instances are subject to the prejudices and limited knowledge of the author. Many interpretations are tentative and will be changed as more is known concerning the geology of the region. Known geologic features were observed and an attempt has been made at presenting not only a plausible explanation for events and their sequence, but also to present what I consider to be the best explanation or explanations. These, would of necessity, clarify relations now extant in the region.

The oldest rock unit known in the region is the Pinal Schist. The Pinal Schist is actually subdividable into a number of sub-units (as by E. A. Schmidt in the Mineral Mountain area, unpublished M.S. thesis, University of Arizona, 1966). These sub-units are now being mapped by the U.S.G.S. in an attempt to come up with a workable system. The Pinal Schist varies widely in composition from very calcareous to quartz-sericitic or rarely of nearly pure quartz. The schist may be variously of a limestone, arkose or rhyolitic, quartzite derivation, respectively. The Pinal Schist was intruded by the Madera Diorite (dated at 1730 M.Y. and/or 1540 M.Y.) and possibly at this time by the Manitou Granite in Older Precambrian time. Tectonism previous to the intrusion or intrusions, which was probably related to igneous processes, metamorphosed and folded the proto-Pinal Schist units into a series of northeasterly trending folds. This event has been referred to (most recently, by D. E. Livingston and P. E. Damon) as the Arizonan Revolution. Stress orientation was probably horizontal compression in a northwesterly or southeasterly line.

The intrusion of the Ruin Granite (Oracle Granite equivalent, both dated at 1420 M.Y.) as a batholith in central Arizona is referred to as the Mazatzal Revolution. At least these two and probably a larger number of smaller orogenic and/or intrusive periods occurred in the Old Precambrian.

In the Globe-Superior region, the contact between Pinal Schist and Ruin Granite is believed to be fairly linear and of fundamental significance in later intrusion and mineralization localization (N. P. Peterson, 1962). The Pinal Schist was faulted in a graben-like manner into a basement of Ruin Granite for the region from Miami-Inspiration to Ray. The trend of this graben, as determined by measuring the trend of the northern contact between Ruin Granite and Pinal Schist was approximately N70°E. This was determined for the area of schist and granite outcrops near the Superstition Mountains (in the west) to the schist-granite outcrops in the Copper Cities area. The southern contact is shown to be vertical to nearly so (in geology of the Porphyry Copper Deposits, Ray Mine, p. 181). The northern contact dips, where observed and as projected, generally as one would expect if the schist does in fact represent a graben with a distinct linearity of east-northeasterly trend (N50°E). This may have been followed by north-south compression (?) which caused major strike-slip faults, trending approximately N30°W, to form. These faults were right lateral strike-slip faults which disrupted the continuity of the graben and similar structures probably extant in other areas. Evidence for this is the assumed local reorientation of segments of the schist-granite contact to a more north-northeasterly trend (generally N45-55°E $\pm$10°) i.e. as the Sleeping Beauty zone. It is my hypothesis that this reorientation allowed a conjugate shear system to develop: also, that this event or occurrence established a fundamental pattern for strike-slip displacement(s) in Younger Precambrian time (Grand Canyon Disturbance) and later tectonic periods. One first order strike-slip direction was approximately N30°W and the primary or first-order "conjugate" strike-slip direction had a N45-55° $\pm$ 10°E direction (also an available slippage site because segments of the schist-granite contact now lay with this trend). Evidence has not been found by me to indicate whether or not this faulting occurred before or after deposition of the Apache Group. However, I am of the opinion that these fault systems also represented release directions subsequent to the formation of the "schist-graben" and, as such, also had a dip-slip component.

Seas encroached upon an essentially featureless peneplain allowed deposition of the Apache Group. The epeirogenic uplifts which may have occurred and/or fluctuations in sea level controlled the nature of these deposits. Some acid volcanism may have also occurred during this time period (Shride, 1960). Extrusion of basalt flows covered the Mescal Limestone in many areas. The Troy Quartzite was then deposited unconformably upon this sequence. It is of note that no Troy Quartzite has been mapped north of the Magma Mine in the Superior Quadrangle and so this may have been a high area at that time.

The Grand Canyon Disturbance may be the time span during which the N30°W and complementary structures (N45-55° $\pm$ 10°E trend) were formed, or reactivated strongly, with the accompanying intrusion of diabase (dated at 1140 M.Y. in the Sierra Anchas). The diabase did not spread significantly in Pinal Schist or in the Ruin Granite. However, some rather small sill-like bodies do occur in the Pinal Schist. Large areas of the Ruin Granite were

not intruded by diabase; this fact is probably a reflection of the relative differences in competence between schist and granite. The "competence difference" between Ruin Granite and Pinal Schist, as well as other factors, can be considered as of great significance in the later localization of ore deposits in the region: the large ore deposits found to date have been in the schist (south of the northern Ruin-Pinal contact and north of the southern contact near Ray). The diabase formed extensive sills and dikes only in the Apache Group and Troy Quartzite (Shride, 1960).

Cambrian Bolsa Quartzite was deposited unconformably upon these units after an apparent lapse of 540 million years (assuming 1140 M.Y. date correct for diabase and 600 M.Y. for beginning of Cambrian). This time span has no known or inferred history. It is of note that the Troy Quartzite and much of the Precambrian Basalt had been stripped and/or not deposited in the Magma Mine area previous to the deposition of the Bolsa Quartzite.

Ordovician and Silurian units have not been mapped in this portion, nor in the greater part, of Arizona.

The Devonian Martin Limestone was deposited upon a surface of moderate relief which consisted predominantly of Bolsa Quartzite in the Superior area, but it is also found on Troy Quartzite (as hills ?), diabase, etc. The hills which may have existed probably had an east-northeasterly trend, but this is indeterminate. Sedimentation was apparently fairly continuous throughout the Mississippian and Pennsylvanian-Permian Periods. Little or no record of igneous activity and/or tectonism has been found for this time period in this area, or for that matter, in Arizona.

No rock units have been identified as Mesozoic, therefore, the area may well have been a source for a major portion of the sedimentary rock units of this age found in other portions of the state. Uplift and erosion may have occurred at this time with no structural interpretation possible due to the absence of rock units.

The advent of Larimide tectonism may be represented by the numerous dioritic to quartz-dioritic dikes and stocks found in the region. The controls for these intrusions appear to be fairly local structures; as contacts, minor faults, etc. The Silver King diorite and its multiple phases may have been intruded at this time. The southern contact of the intrusive with premineral rock units is rather linearly controlled be a west-northwesterly trending structure or structural zone. The Silver King intrusive complex has not been dated, but dioritic to quartz dioritic intrusives to the south have been dated as Larimide (S. C. Creasy, 1968 and Damon, 1970).

I have reviewed those dates presently available for this region and believe that not only do the dates published to date support a more unified concept for the intrusive history of the area, but also that the differentiation sequence suggests this also. Table four lists rock units in the immediate area and adjacent districts with the published dates for these units. I interpreted this data to possibly signify a general differentiation sequence from dioritic to granitic rocks with a sequential change in dates also. Of particular interest are some of the apparently "anomalous" dates (such as the

Schultze 58 or 60 M.Y. vs. Granite Porphyry 62 M.Y.) which do not agree with observed field relations. I would suggest that these dates represent thermal events which have reset the "radiometric clocks" of minerals in relation to their retentivity as well as the intensity of the event. The dates indicate a high(?) occurrence of dioritic intrusives for the region approximately 70-69-68 million years ago. With granodioritic or quartz dioritic intrusives occurring at 68, 67 M.Y. The quartz monzonitic intrusives have a nearer relation to the 64, 63, 60 million year dates. The 58 million year date on Schultze may reflect the aforementioned thermal resetting by Granite Porphyry 62 M.Y. ago. Although some dates do not conform to this sequence (as the quartz diorite at Christmas and others), it is highly probable that this is due to 1) the different intrusion-controls present in this or any other district, 2) differences in rock classification, and 3) the dating of a different phase or phases of an intrusive. With all these limitations, age dating plus good geology can be used very effectively in the localization of favorable exploration areas in the region.

The Willow Springs Granodiorite (dated 117 M.Y.) probably antedates the more intense Early Tertiary igneous activity. This intrusive and the later Lost Gulch Quartz Monzonite were emplaced apparently following the trend of northeasterly structures and the foliation in the Pinal Schist. These intrusions probably followed high-angle faults which were parallel to the first-order faulting direction established in Precambrian time. The Solitude Granite (Sg) was possibly intruded at this time.

The Lost Gulch Quartz Monzonite in particular, seems to have followed the Older Precambrian fault contact between Pinal Schist and Ruin Granite, now possibly represented by the Sleeping Beauty fault zone. This zone has probably been active as late as the Plio-Pleistocene Epochs at which time basaltic magmas may have found access to the surface through this zone (this rock unit had previously been mapped as diabase). Alternately this unit may indeed be diabase lying across the contact (as is the case at Ray).

Doming may have been associated with the intrusions of the Lost Gulch Quartz Monzonite, the granodiorite of Gold Gulch (place in time uncertain) and Willow Springs Granodiorite. However, basic controls in space of these intrusives are linear. This is evidenced by their outcrops and from interpretations made by N. P. Peterson, as well as his U.S.G.S. mapping.

The intrusion of the Schultze Granite has been considered to be linearly controlled (T. A. Clary, 1970). This intrusion is considered by me to have been allowed ingress along an approximately N60°E line, representing the major break to the northwest of the Pinal Mountains which acted as a block or buttress.

Previously extant east-northeasterly structures continued to exert significant controls on intrusive centers and/or mineralization (such as the Granite Porphyry and to some extent the granodiorite of Gold Gulch) in the Lost Gulch Quartz Monzonite and also in the Castle Dome, Copper Cities, Globe and Superior ore bodies. The Miami-Inspiration ore bodies probably are more closely related to cupola-like effects of the Schultze Granite intrusion. Major copper mineralization is thought to have a genetic association to Granite Porphyry (N. P. Peterson, 1962, p. 36). As such, the strong N70°E trend to the Granite Porphyry intrusive(s) is of great importance.

TABLE FOUR

LOCATION	ROCK UNIT NAME	COMPOSITION AND/OR DATABLE MINERALS	DATE (MILLION YEARS)
Globe-Miami	Willow Springs Granodiorite	(border facies is a granite, k.spar, musc.)	117
	Lost Gulch Quartz Monzonite	quartz monzonitic (2 phases)	64
	Schultze Granite	quartz monzonite	58 60
	Granite Porphyry	quartz porphyry to quartz monzonite	63
Ray	Granite Mnt. Porphyry	quartz monzonite	63
Troy	Troy diorite	dioritic	71
Christmas	Quartz diorite porphyry	Same as rock unit name	62
San Manuel	Altered granodiorite	Same as rock unit name	67
Copper Creek	Copper Creek Granodiorite	Same as rock unit name to dioritic	68
Tortilla Mnts.	Sonora diorite	Same as rock unit name	69
Red Hills District	Hackberry diorite	Same as rock unit name	68
	Grayback granodiorite	Same as rock unit name	63
	Grayback dike system	5 facies, dio. to qtz. mon. porphyry	63

The entire Larimide period of tectonism, and/or mineralization may be considered as stemming from a regional epeirogenic-like uplift with underlying pockets or magma chambers associated with a larger, heated source. Each intrusive in this area may be a portion or segment of this chamber which "bled-off" through available structural conduits and rose to an equilibrium level. These intrusions can also be considered to have occurred in pulses which changed in composition and texture and culminated in quartz-rich, mineralizing, fluid releases which were deposited at very near the same levels at which the pre-mineralization intrusives came to rest. This general uplift was modified by the complex structural settings encountered at these shallower depths (as compared to the simpler, stronger structural elements that are capable of penetrating to depths of several miles) of emplacement and mineralization.

The intrusion of the Willow Springs Granodiorite, Lost Gulch Quartz Monzonite, Silver King diorite and granodiorite of Gold Gulch probably in-filled the most readily available structural conduits, as the Sleeping Beauty fault zone and/or Ruin Granite -- Pinal Schist contact, with the consequence that the later intrusion of the much larger mass of Schultze Granite followed the previously mentioned N60°E break. This break was probably a consequence of the continued differential rise of the general area and a northwesterly termination of the Pinal Mountains block (which may have trended N30°W). All rocks other than those Older Precambrian in age have been stripped from a majority of the northern portion of the Pinal Mountains. Alternately, the Schultze Granite intrusive may also have been localized by the intersection of the N45-55° ± 10°E fault system, (established as such in Precambrian times) elements of the conjugate N30° ± 10°W fault system and a number of sub-parallel elements in the N75° ± 10°W system which cut the region. Some of the strongest hypogene mineralization is found to have the N30° ± 10°W or N45-55° ± 10°E direction. However, the Granite Porphyry generally has a N70°E trend.

The structural systems have surely been recurrent in time and the unraveling of their relative times of movement is extremely difficult as well as tenuous. The relations now found can be explained on the basis of vertical-uplifts with strike slip displacements secondary to dip-slip movements at the time of intrusive(s) emplacement and/or subsequent mineralization. The peak or maximum uplift area was probably to the south and east of the Schultze Granite intrusion (Pinal Mountains block). The Schultze Granite and associated mineralization are thought to have only recently been completely exposed. Good evidence for this is found in the clast composition of the Gila Conglomerate east of the Miami Fault, which contains abundant Schultze fragments only in the uppermost portion (Peterson, 1962). The Miami-Inspiration ore bodies are thought to have been exposed to secondary enrichment in Early or mid-Tertiary times. This was probably a consequence of faulting related to vulcanism to the west. That we are looking at only the very uppermost portion of the Schultze Granite, is also indicated by the many thin, shell-like schist remnants found covering the Schultze or isolated in the main mass.

Radiating from the main "buttress" found by the Pinal Mountains block were a series of faults which had rotational movements along them. These faults followed or were modified by the previously extant fault systems. This type of displacement is attested to by the differential erosion and/or preservation of the numerous pre-mineral units in the blocks. Minor thrusting, grading into glides or gravity slides, occurred along the margins of the blocks (as the Castle Dome Block) which were affected by these displacements. Units were brecciated (especially Pinal Schist, as at Miami, Occidental's Miami East, Cactus-Carlota, etc.) and the Apache Group - Paleozoic sedimentary rocks were brecciated, at times on small scale, but also, on the scale of thousands of feet (as at Superior and south to Ray). The mega-brecciation present is indicative of the tremendous amount of faulting which occurred, but I consider that actual displacements were in most cases of minor extent except where a high area had an adjacent low into which material was sloughed off. The Larimide displacements consisted more of a local bending, shoving, plastic type, of displacement as intrusion-mineralization proceeded.

Areas adjacent to the Pinal Mountains block and Schultze Granite, as the Globe Hills Block, Inspiration Block and the area between Superior and the Pinal Mountains, probably tilted towards the intrusion center and suffered some collapse to form rim or ringing synclines (which have been related to meteorite impact areas, salt domes, and doming by granitoid intrusives). Subsequently, drainages occupied these lows and also thrusting or gravity slides of a great displacement sloughed into and/or across them. The Superior area was tilted (previous to mineralization) at this time also.

It is important to recognize that Larimide, (Late Cretaceous-Early Tertiary), Mid-Tertiary and/or Pasadenan events, represent a continuum of structural activity. The deformation(s) are not everywhere contemporaneous and so, neither are rock units formed during these times. However, we catagorize these events according to peaks represented by structures, rock types or compositions, age dates, etc. This is a convenience which may or may not agree with the geological facts. This concept is of particular importance when applied to an understanding of the post-mineral units found in the Globe-Superior region and surrounding areas.

Previous to the Mid-Tertiary peak in vulcanism, probably directly related to the impending events, block faulting occurred (as "tensional release" of the Larimide uplift(s) which lead to the formation of basins and ranges probably very similar to those now present in the region. The "up" blocks were actively stripped with the eroded materials forming rather coarse deposits of Whitetail Conglomerate or equivalents in small deep basins, canyons and/or covering broad areas. The Whitetail Conglomerate is locally dated (Ray area) at 34 M.Y. (personal communication, J. D. Sell, 1970). That the Superior area (Magma Mine, etc) had been tilting previous to Mid-Tertiary events and continued to do so is evidenced by recent studies of the mineralization in the mine (Peterson and Hammer, 1968) and also by the presence of a slight angular unconformity in this area and a greater angular unconformity present in the Haunted Canyon area. The major drainages for the area were probably approximately north-south (in the Pinal Mountains and Mineral Mountain Blocks). It is possible that the Whitetail Conglomerate has not been distinguished from a later conglomeritic unit which may be more closely a correlate of the Earlier Volcanics. This distinction

represents the difference between the "true" Whitetail Conglomerate and a conglomerate which slightly antedates the deposition of Earlier Volcanic units (by their rapid erosion into basins) as well as possibly occurring throughout the volcanic pile. The distinction is important not only for a proper understanding of the geologic history for local areas but also because there may well be sites in which both conglomerates are present underneath the dacite and as such, have added or will add considerable depth to drill holes in these areas (as DCA-1).

Mid-Tertiary events can be broken into two main events based upon rock types present, the earlier basaltic to rhyolitic vulcanism and later dacite ash-flow. This (probably Late Oligocene to mid-Miocene) volcanic activity progressively migrated eastward from the Goldfield Mountains, through the Superstition Mountains area to the Haunted Canyon area (personal communication, Michael Sheridan to James D. Sell, 1970). The relation in time of the east-southeasterly migrating volcanic center to north-south faulting in the Mineral Mountain Quadrangle and areas south-southwest and/or west of Superior is uncertain. However, it is significant that the Haunted Canyon Caldera (as delineated by D. W. Peterson, 1961) is found at the intersection of this north-south trend and the projected east-southeasterly migrating volcanic centers.

The Earlier Volcanics have not been dated in the immediate area. However, dates of 25,000,000 years and younger have been obtained for similar units, to the west, in the Superstition Mountains complex. Mineralization may be related to Mid-Tertiary events and now represented by the St. Anthony Mine (near San Manuel), Reymert and Mineral Mountain deposits, etc. The 20 M.Y. date for the dacite or Apache Leap tuff, places an upper limit as to the age of Earlier volcanic units. Approximately in the Late Oligocene Epoch a quartz latitic to latitic, tuffaceous volcanic unit was deposited in the Haunted Canyon Area. This immediately overlay Whitetail Conglomerate or other pre-volcanic rocks in the area. This was followed by a period during which a basaltic appearing unit(s) was extruded. This unit has been termed a basaltic andesite by me to reconcile drill-hole logging which has variously described this unit as a basalt or andesite: this unit reaches a total of nearly 1,000 feet in one of the drill holes, DCA-3, which penetrated the main dacite mass. Evidence for pre- and post-basaltic andesite relief and/or accompanying tectonism is given by the widely variant thicknesses of the andesite and its absence in many places. The basaltic andesite(s) are cupriferous, the copper occurring as oxides lining silicified fractures, which may be exotic or locally derived from accessory copper minerals (see file memo to J. D. Sell, dated 4-1-71). The basaltic andesite(s) were followed by a complex of volcanic glasses and/or rhyolitic to latitic flows. The area south of Haunted Canyon and west of Power's Gulch has been interpreted by me as site for one or more vents and related dike systems, probably representative of a caldera. Subsequently, the Earlier Volcanics in this area were tilted to the east. This is suggested by their present dips and manner of outcrop. There are also indications that there is an angular unconformity between Earlier Volcanics and the overlying dacite, in that their flowage planes do not coincide and their measured dips deviate from one another by as much as forty degrees. It is my opinion that the Earlier Volcanics dip consistantly southeasterly under the dacite to form a structural block trough trending approximately N30°E. The total depth of post-mineral

units in this trough is known to exceed 4011 feet (drill hole DCA-1). This trough may have been filled not only by Whitetail Conglomerate (with pre-mineral clasts) but also by volcanic debris derived from a northwesterly source.

Dacitic domes (?), plugs and vents are numerous in the Haunted Canyon area and these probably contributed to the abundance of structural activity in the Miocene Epoch. That numerous vents were the source for the dacite sheet is inferred by its tremendously large volume (approximately 150 cubic miles as per D. W. Peterson, 1968). Although difficult to invision in a short time period, it is evident that a major portion of the dacite was extruded closely enough in time, to form essentially one cooling unit. However, there are numerous areas where the dacite has various zones or units repeated. The dacite filled those basins and/or topographic lows available and is now preserved in some of these same lows. Chief among these "preservation" sites are the Spine Syncline in the Copper Butte area, a syncline near the Rockingstraw Mountain area, and the "syncline" north of Ray and extending nearly to Haunted Canyon. It is of note that the eastern edge of the dacite is anomalous in that it rises as a scarp over the Power's Gulch area. This is probably due to north-south block faulting, with the major north-south fault well within the main dacite mass.

Pasadenan events have consisted essentially as a continuation of the Basin and Range-type faulting with the tilting of both raised and down-dropped blocks. These displacements are considered by me to have followed previously established faulting planes and are now important guides to the structural setting in previous orogenic periods. A re-occurrence of faulting along N30°W and N30°E lines with later north-south displacements has faulted wedges of dacite and/or Gila Conglomerate up to very recent times. The recency of some of this faulting is indicated by the "perched" remnants of Gila Conglomerate found on the main Schultze Granite mass and also by the Miami fault, etc. Major thrusting probably occurred in the Pliocene possibly related in time to the extrusion of basalts throughout the region whichwhich are often intercalated with Gila Conglomerate. The largest thrust recognized to date is in the Globe Hills and Globe Valley blocks where Madera Diorite overlies Whitetail Conglomerate and dacite as well as other units. The Cactus-Carlota breccia-mass, dacite and Whitetail Conglomerate, etc., was probably faulted into place at this time and cut by later dip-slip movements on the Kelly Fault. There is also a major north-south fault occurring as the western boundary to the Mineral Mountain quartz monzonite which has Gila Conglomerate equivalents(?) deposited as fans(?) against the fault breccia.

Notes with application to the regional geology and work sheets used in this study are submitted as Appendix G, this report.

George S. Barnett

G. S. Barnett

GSB:sh

TAB

Appendix G

Appendix G of Addenda G

(Notes with application to structural interpretation(s) of the Dacite plateau & region, Superior East)

E.B. Mayo (S.M.E., 1958) noted four directions of regmatic shear: NE & NW; N.S. & E.W. Also notes nature of geological problems - interpretation as being 2 dimensional in plan or map, plus one additional dimension for section, and adds third dimension of time. Therefore, interpretation must be made with due consideration of space & time relationships. Pertaining to the structural history, Dr. Mayo emphasizes that the questions; Which structures were most active?; and When were they most active?, are of greatest importance. Also, one must answer: Where were sedimentary basins?; When were they deformed?; What is the sequence of intrusion, extrusion, differentiation, alteration, etc.?

Dr. Mayo's primary directions were:

N.30° W., N45-55°E., N 60°-70°E, N-70°W+10°

N-S., & E.W.

Pelletier & Creasy (San Manuel Orebody) noted N & E structures (as mapped by Wilson) to be strongest - or latest in the San Manuel orebody. They also noted N60°E fracs to be of greatest abundance. They could not, however, distinguish post-K & pre-Pliocene from post-Pliocene

structures.

Moolick & Derek (Morenci, from Geology of the Porphyry Coppers) noted that the strongest and best mineralized fractures were from N45°-N65°E.

Wilson, E.D. (San Manuel) labeled or catagorized structures as follows:

Oldest structures 1) Post-ore ave N66°W; 26°SW

4) Regional 2°-25°NE Chlorite alteration. 2) N-25°W Steep to E.

5) Gila Cgl. N50°W 35°NE 3) N-60°E Vert to 65°SE

North orebody ave.: 400' wide, N60°E, 55°SE

South orebody ave: 1000' wide, N60°E to N45°E (in west)

Dips SE to NW.

Creasey S. (Bagdad) "ore localization by set of conjugate shears."

N.P. Peterson (Globe-Miami districts)

Old Dominion (Nb) N50°E. ± 10°

to So. aux. changes to N70°E ± 10° in

Miami Dist Granite Mt Porphyry N70°E: Copper Cities area and N85°E in Castle Dome (Drag?) area.

P. Badgley (Major lineament trends S.W. Cordillera)

p.117

1) N50°E ± 15°

2) N40°W ± 10°

3) N75°W ± 10°

4) N-5°E ± 10°

Major Joint trends (4-corners area)

p.118

1) N 50° E ± 10°
2) N 45° W ± 10°
3) N 70° W ± 10°
4) N 5° E ± 10°
5) N 15° W ± 10°
6) N 75° E ± 10°
7) N 55° W ± 10°

Hernon Jones (Central Mining Dist)
" fan-array to faults indicated, although conjugate sets NW (30°) apparent.

St. Anthony Vein, S. Creasy

stages
1) N 40° W
2) Rhyolite
3) Veins in Rhy N 40° W SW Vert ??

Pliocene : N-30° W or 25° W - cutting faults - of ~~N~~ 60° - 80° ~~NE~~ dip
Northerly tension fractures

Globe - Miami Area : N 50° E = SE termination for sch - granite contact in Pinal Mts.

In early Pliocene region near sea level.
The schistocity and folding direction of the Pinal Schist are approximately the same.
Alluvial fans in QTg contains

Schultze Granite clasts only in uppermost beds.

The fact that the granite porphyry outcrops at present with a trend of N70° ± 80° E can be misleading in that rotational movements are inferred for the Jewel Hill, Sulphide and Kelly faults, and presumably for the Miami System trending N.E..

Causes of fracturing in oredeposits:

a) Peter's shattering explanation ??
b) Tectonic stress
c) Cooling
d) Shrinkage due to alteration
e)

McKinstry H.E., 1955 — "Causes as ....,
" Explosion breccias, contraction on cooling, mineralization stoping, tectonic forces."

" Meanwhile, until some generally applicable mechanism is established, we may have to live with the rather unsatisfactory comprimise conclusion that mineralizing solns were not choosy about the origin of the fractures they utilized and that causes of fracturing were different in different districts.

Esperanza orebody : Faults NE to ENE 1st
NW 2nd — shea
N 3rd

Structural History (folding).
Laramide { compression
uplifts ← + thrusts
folding

Miocene Uplift & folding
also thrusts

Distance from Miami East (center of body) to
Old Dominion — replacement horizons' termini —
= 20,000' bearing due east.
Ore terminated 3600' S.W. of shaft
A. (Collar ≈ 3670')

Creasy, S. (Mammoth - St Anthonys) Mammoth
Fault had oblique slip, normal
slip to northwest. (700' of dip slip)
N 25° W, 60-80° NE dip. ⇒
belongs to N-30° W system.
2nd set consists of antithetic faults
of N 20° W to N 50° W strike
steeply dipping to S.W..
Gila Cgl. cut by Mammoth & other faults.
Oxidation of orebody is pre-faulting.

Superior: Paleozoics 8 mi So., strike
≈ N. dip 30°-40° E.
10 mi No. " "
Angular discordance 15°-25° between
Pal. & Tw.

B.S. Butler (Some Ariz. Ore Deposits)

Principal folds NW to No., Others
cross at right angles and are evidenced
by anticlinal domes and synclinal
basins.

Tension features: In S.E. Ariz, little
or no displacement, NE & NW systems??
N.E. fissures commonly extend in
en echelon patterns rather than continuous
for long distances.

Predacite

Bedding faults between "Troy" & Martin.
Underground 7000' ~~fractures~~ 10'-20' above Martin
ave. east to N80°E
ave dip: surface to 900 = 65° N
900 → down 78° S
No. wall 475' E vert 500' displacement
N-side up. net displacement ≈ 55°
angle to beds.

Post dacite: N & NW & NE
Concentrator: 70 S.W. Vert 2000'
Miami: 500' strat. displacement

George Kreisch: Ph.D. Dissertation, 165 pps. 1947) 30 plts., 3 figs.; Structural Control and mineralization at the Seventy Nine mine Gila City Arizona, Econ. Geol. Vol. 44 pp 24-39 (1949)

Christmas: Pre-L.??
Laramide = Foldings & low angle faulting.

Pre-Tertiary units dip ≈ 15° S
Compression evidenced by Bedding Plane Thrusts

1) Pre-ore (O'Carrol, Keystone (No. point)
N-S system } Regan Camp Fault.
"Orebody" fault = N 30° E System

2) Shear zones N-60°-70° E
Negligible vert. movement

3) Acidic magmas from Central Arizona Batholith emplaced in E-W system. (N 70° E?)

4) More N-S displacement

note → Shearing N 70° – 85° E.
Tension N 55° E.

At this time or slightly later
Gulch Zone (E-W) N 70° E
mineralization in "79" Mine.
All show vert displacements ~~with~~ So.
Block generally up. – some displacement
post ore.
Long axis N. 70° E ; this 2nd phase or
period of pre-ore faulting shattered
and made permeable dikes and limestones.

Reverse Faulting in crest of Dripping
Spring Mts. ; evidence of compressive phase
of Laramide Revolution.

Post-ore Main Fault } N 35°-45° W
Middle Mountain View } 60° NE
Late Tert Additional Movements along
some pre-ore N 70° E faults
Post? QTg – minor faulting Dip 30° W.

Data relating to rimming synclines.
Wilshire and Howard (1968)
Structural pattern in central uplifts

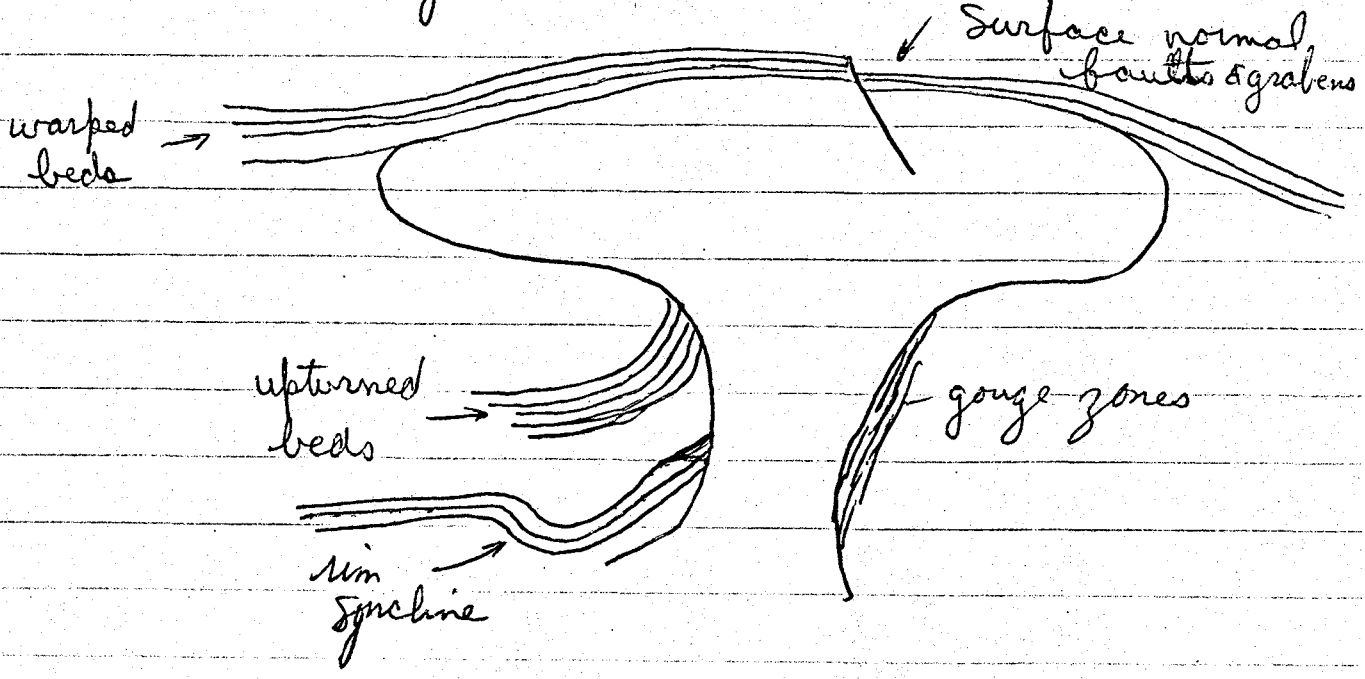
of cryptoexplosion structures as typified by Sierra Madera: Science, v. 162, p. 258-261.

" Outside central uplift (5 km. diameter) is a synclinal (ring) depression 1-3 km. wide and an outer rim where rocks are locally cut by concentric fractures and normal faults downthrown toward the center. (Figs. 1 & 2)

— 5 km. = 3.1 mi. ; 1 = 0.62 mi 3 = 1.864 mi

"Rim Synclines" Rimming synclines
← G.S.B.

M.P. Billings Salt Domes



p. 271 fig 181 Expl. or diagrammatic of Schultze emplacement?

p. 213 fig 182 Wrench faults esp. Neuchatele & So. of Geneva

p. 223 fig 189

Great Glen Fault in Scotland obivously <u>no</u> <u>elongation</u> of intrusion along major northwest fractures.

<u>note</u> — Compare to dike swarm of Tertiary age in Fig. 256.
pps. 201 & 202 & Reverse situation in Ariz??

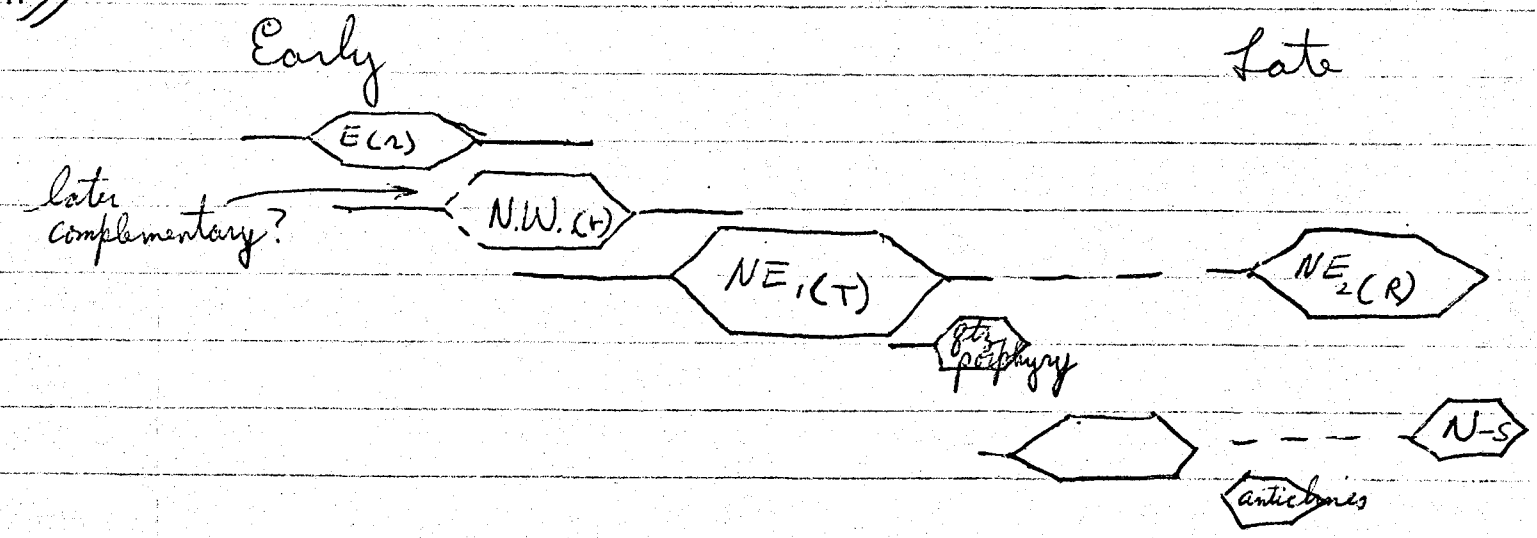
J. D. Sell thesis:
Fault systems: North, east, NE, NW., (N 5% 5 W fault) N system
400' horizontal, 90' vert <<
East side up, West down
over 1500' long
Normal & dips west.

Faulting sequence in the Magma Mine area:
E to NW early (rotational)

P.P. qtz ⟶
later ⎫ early NE translational
⎭ No. set & late rotational NE set

General Review:

Note: Structural Event



Notes USBM RI. 3919 Copper Butte

Copper Butte occurs in Tw. faulted against granite pp.
Tw dull gray or reddish brown
Tw tight not admitting water circulation, except on faults.
10' Vitrophyre
10' Tuff.

USBM RI 5336 April 1956 March?

San Manuel fault low angle type, cut however by N 20°-30° W steep faults.
dip = 30° SW but 15° or less at depth.

QTg tilts N20°-45°E, NW strike.

Cu. 0.5 or >
ore body ≈ 6800' long N60°E trend
× 3000' width
1800' ore grade

Wilsons Systems N-S; E-W; N30°E.; N45°E;
N60°E.; N60°W; N45°W; N30°W

Table: Level 1285-1415 ↓(at depth)↓
Ave: E-W = 40% (constant)
N-S = 20% (fluctuate)
N-45°W = 14.7% (Nil)
N-45°E. = 13.9% (0 at depth)
N-60°W = < 10%
N-60°E = < 10%
N-30°W = 5%
N-30°E = 7%
low ∠'s = 30%

note: probably of greatest significance is the fact that the N45°W & N45°E fracs peter-out at depth.

gouge on low angle fracs & wavy traces.

Wavy fracs (steep dip) abundt on N-S & E-W systems; less common on N60°W & N60°E; rare on others.

Relative ages: (all premineral) {Pre porphyry & post p.p. pre-diabase (GSB??)

Many shears in cgl. some low angle pre-mineral faults; many post-mineral which cut or displace all others.

Detailed Surface mapping in QTg shows N-S, N45°W, N30°W as most common systems few N30°E or E-W.

— N45°W cut all others —

1957) N-20°-30°W in upper plate of San Manuel Fault only. E-W or N-S vert = best mineralization. >7000 fracs, 26,750' studied.

Nielsen, Richard L. "Hypogene Texture and Mineral Zoning in a Copper-bearing Granodiorite Porphyry Stock, Santa Rita New Mexico."

Santa Rita stock formed from quartz monzonite magma intruding gently dipping sedimentary rocks, probably within 1500' of the surface. Crystallization = solid shell of equigranular or seriate textured granodiorite around partially crystallized mush.

Tectonic adjustments fractured shell emplacing aplites and porphyritic granodioritic dikes in the solid shell."

Geology & Ore Deposits Globe-Miami Areas:

Structure p 45-57
Geologic History 63-66

Miami - Inspiration p. 86
Castle Dome p. 88
Copper Cities p. 89
Cactus p. 95
Carlota p. 139

Structural Control p. 142
Economics p. 145

Peterson's Structural Blks:
Globe Hills, Globe Valley, Inspiration.

Thrust in Globe Valley = Madera over Td.
Td 400' deep under Pinto Creek
2 drill holes 3500' SW show 50-225' Td
overlain by 1000' Gila Cgl.
Td ≈ 100' underlying thrust in
A-Shaft.
but 5000' S.W. there is 1050' Td

Copper Cities 10,000' x 3000' alteration
zone, long axis N60°E, N60°E trend
for Sch - pЄ gr contact.

Empress Claim 3 churn drill holes
near Empress vein. (p. 146 bottom)
1) 625' Td, 785' Tw
2) 535' Td, 165' Felsite
3) 890' Td, 240' Felsite
None bottomed in premineral.

Powers Gulch { 1930-31 5 Drill holes
500' - 1,235' Td & tuff
70' - 410 Underlying Sch & gr

most logs show leached capping
=< 0.3% Cu.
156' of 0.5+ % Cu as
silicates or carbonates, no sulfides.
400' - 1000' from edge of Td.

Notes from conversation with Dr. M. Sheridan:
Bull. of Volcanology - soon to be published paper.
Vitrophyre generally 200' or less above base of dacite.
Dacite (qtz latite) is overlain, however by vitric welded, dacitic (to qtz latitic) tuff.
One tuff dated at 22.5 My
" " 21.0 My.
20.0 My.

Sequence at Pickett Post Mnt.
tentatively correlated with Geronimo
Head formation in Superstition Mts.

M.S. Thesis by Stuckless - Geology
of the Volcanic Sequence Associated
with the Black Mesa Caldera, Ariz.

Notes on Dating Used:

" Rententivity of Sr seems only slightly
stronger than AR. Mineral retentivity in
the order coarse-grained musscovite > sericite
> fine bio.
& hbl > bio.

Dating & dates for Rocks in Superior -
Ray & Globe - Miami Region.
Dates from Damon, et al. & USGS.
also from D.E. Livingston's Dissertation
(Tables Xeroxed & pertinent literature
as part of this appendix).

Total Explanation of Regional
Geology as understood by me at
present time:

Qal — Sedimentary deposits

QTb — Plio-Pleistocene basalts

QTg — Gila Conglomerate + felsic (rhyolitic) tuffs

Tqmp — Quartz Monzonite(s) in the Wood Camp Area & possibly the Iron Mt. Intrusive.

Td (20 M.Y.) "Dacite" & subunits.

Tw? — Some "Whitetail Cgl. may occur here.

Tvt — Water-laid?, well bedded tuffs

Tql — Quartz latite flow?

TrT — Tuffs Breccias, perlite, rhyolite

Tb — basalt or basaltic andesite

Tlt — latitic tuffs & quartz latitic lapilli breccias

Tw (34 M.Y. near Ray) Whitetail Cgl.

Angular Unconformity

Lsq | qp (58 M.Y.) / qmp (62 M.Y.) Laramide Schultze granite (main mass quartz monzonite porphyry) later? phases granite porphyry

Lgm (64 M.Y.) Fost Gulch quartz monzonite

order indeterminate:
- Lgd — Gold Gulch granodiorite.
- Wsg — Willow Springs granodiorite
- Sg — Solitude granite.

dp — diorite porphyry (relations to WSG & Lgd indeterminate

Unconformity

IPnl Naco Formation or Group
lower members, Penn-Perm.

Me Escabrosa Limestone

Dm Martin Formation

Disconformity

Ꞓb Bolsa Qtzite.

unconformity locally an nonconformity

dl b 1140±40 M.y. Diabase —— Grand Canyon Disturbance?

pꞒT Troy Quartzite

disconformity

pꞒa Apache Group

pꞒb Basalt

pꞒm Mescal Limestone

pꞒDS Dripping Spring Fm

pꞒpS Pioneer Fm.

unconformity

pꞒrg Ruin Granite Mazatzal Revolution?

pꞒmg Maritou Granite?

pꞒmd Madera Diorite (qtz diorite)

pꞒpi Pinal Schist

or pꞒsc

TABLE I. K/Ar Dates of Intrusive Rocks in Arizona and New Mexico[1]

No. on Fig. 1	Locality	Rock	Age	Reference
1	Mineral Park	Quartz monzonite	72 m.y.	(56)
3	Bagdad	Quartz monzonite	71 m.y.	(56)
4	Copper Basin	Granodiorite	64 m.y.	(35)
7	Walker	Granodiorite	64 m.y.	(46)
	Big Bug Creek	Granodiorite	70 m.y.	(51)
8	Ajo	Quartz-orthoclase pegmatite	63 m.y.	(56)
9	Globe-Miami	Lost Gulch Quartz Monzonite	64 m.y.	(55)
		Schultze Granite	60 m.y.	(55)
		Granite porphyry	62 m.y.	(55)
		Border facies of Willow Spring Granodiorite	117 m.y.	(55)
11	Ray	Granite Mountain Porphyry	63 m.y.	(39)
12	Christmas	Quartz diorite porphyry	62 m.y.	(39)
14	San Manuel	Altered granodiorite porphyry	67 m.y.	(55)
15	Copper Creek	Copper Greek Granodiorite	68 m.y.	(39)
16	Silver Bell	Alaskite	65 m.y.	(52)
		Quartz monzonite	67 m.y.	(52)
		Mineralized quartz monzonite	66 m.y.	(52)
		Mineralized quartz monzonite	63 m.y.	(52)
17	Kitt Peak	Granite	27 m.y.	(44)
18	Pima district	Granodiorite	60 m.y.	(39)
		Quartz monzonite porphyry	56 m.y.	(39)
19	Esperanza	Phlogopite-sericite rock	63 m.y.	(56)
		Muscovite-quartz veinlet	61 m.y.	(56)
20	Santa Rita Mtns	Granodiorite	68 m.y.	(56)
21	Patagonia Mtns	Quartz diorite	64 m.y.	(56)
22	Johnson Camp	Texas Canyon Quartz Monzonite	50 m.y.	(49)
23	Cochise Stronghold	Stronghold Granite	22 m.y.	(44)
24	Gleeson	Gleeson Quartz Monzonite	178 m.y.	(55)
	Tombstone Hills	Schieffelin Granodiorite	72 m.y.	(39)
25	Bisbee (Warren district)	Juniper Flat Granite	163 m.y.	(39)
		Rb/Sr	176 and 178 m.y.	(39)
26	Safford	San Juan and Lone Star stocks	58 m.y.	(74)
28	Dos Cabezas Mtns	Granodiorite	29 m.y.	(49)
29	Santa Rita (Chino)	Granodiorite porphyr	63 m.y.	(33)
	Bingham, Utah	Biotite-augite monzonite porphyry	45 m.y.[2]	(53)
	Ely, Nevada	Monzonite	122 m.y.[2]	(62)

[1] Includes Ely, Nevada, and Bingham, Utah.
[2] Average of 2 determinations.

workings. This deposit is now being stripped for open-pit mining by The Anaconda Company.

Radiometric dating has demonstrated that in Arizona, three plutons are of middle Tertiary age (Fig. 2), and Damon and Mauger (56, p. 100) have shown that many volcanic rocks are closely associated in time and space. Their histogram has a very high peak at the Paleogene-Neogene boundary.

The uplift, erosion, and sedimentation during the Cenozoic is of importance to the porphyry copper problem because, in some deposits, the economic value is the result of secondary enrichment by chalcocite replacing primary chalcopyrite and pyrite. In some deposits, such as Castle Dome (20) and Copper Cities (40, p. 95) in the Globe-Miami district, this enrichment is related to the present erosion surface. However, in this same district, Ransome (3, p. 176) has shown that much of the supergene enrichment is older and developed prior to the accumulation of dacitic pyroclastic rocks overlying the Whitetail Conglom-

SHORT PAPERS IN GEOLOGY, HYDROLOGY, AND TOPOGRAPHY, ARTICLES 120–179

GEOLOGIC STUDIES

ECONOMIC GEOLOGY

120. AGE OF SOME COPPER-BEARING PORPHYRIES AND OTHER IGNEOUS ROCKS IN SOUTHEASTERN ARIZONA

By S. C. Creasey and R. W. Kistler, Menlo Park, Calif.

Dating of the Mesozoic and early Cenozoic geologic events in southeastern Arizona is severely hampered by the scarcity of fossiliferous sedimentary rocks of these ages and by the isolation of individual mountain ranges. Isotopic age determinations, therefore, provide definite ages to replace permissive time intervals and aid in the correlation of geologic events from one range to another.

The K-Ar and Rb-Sr ages of biotites from some intrusive and extrusive rocks in southeastern Arizona are listed in table 120.1, and the location of the rocks sampled is shown on figure 120.1. Potassium was determined by flame photometer using lithium as an internal standard. Argon was extracted from the specimens using the technique described by Lipson (1958). Argon was analyzed with a Reynolds-type

Table 120.1.—*Analytical data and isotopic ages of biotites from Arizona*

K-Ar age determinations

No. on fig. 120.1	Rock	Location	K (weight percent) [1]	$K^{40}\times10^{-7}$ (moles per g)	$^{*}Ar^{40}\times10^{-11}$ (moles per g)	Ar^{40}/K^{40}	Age (m. y.)
--------	Juniper Flat Granite [2]	Northern Mule Mountains, Warren district.	5. 49	1. 71	171. 0	0. 01	163
--------	Intrusive rhyolite	Tombstone district	7. 44	2. 32	87. 0	. 00375	63
--------	Schieffelin Granodiorite	do	3. 33	1. 04	44. 6	. 00429	72
--------	Equigranular granodiorite	Pima district	7. 28	2. 27	81. 0	. 00357	60
--------	Quartz monzonite porphyry	do	5. 98	1. 87	61. 5	. 00329	56
--------	Rhyolite tuff	do	7. 16	2. 23	74. 7	. 00335	57
--------	Andesite dikes	do	3. 87	1. 21	16. 9	. 0014	24
--------	Lost Gulch Quartz Monzonite	Globe-Miami district	7. 24	2. 26	83. 6	. 0037	62
--------	Schultze Granite	do	7. 32	2. 28	77. 7	. 00341	58
--------	Vitrophyre (dacite ash flow)	do	5. 67	1. 77	20. 4	. 00115	20
--------	Granite Mountain Porphyry	Mineral Creek district	6. 86	2. 14	79. 6	. 00372	63
--------	Quartz diorite porphyry	Banner district	6. 49	2. 02	73. 9	. 00366	62
--------	Copper Creek granodiorite	Bunker Hill district	6. 27	1. 96	78. 8	. 00402	68

Rb-Sr age determinations

No. on fig. 120.1	Rock	Location	Rb^{87} (ppm)	Normal Sr (ppm)	$^{*}Sr^{87}$ (ppm)	Sr^{87}/Rb^{87}	Age (m. y.)
--------	Juniper Flat Granite [2]	Warren district	384	22. 2	0. 994	0. 00259	176
	do [2]	do	388	21. 3	1. 017	. 00262	178

[1] Frank Walthall analyst.
[2] Same sample used for Rb-Sr and K-Ar age determinations.
[*] Radiogenic.

Decay constants:
K^{40}: $\lambda_e=0.584\times10^{-10}$ yr^{-1}, $\lambda_\beta=4.72\times10^{-10}$ yr^{-1}; $K^{40}=1.22\times10^{-4}$ g K^{40} per g K.
Rb^{87}: $\lambda=1.47\times10^{-11}$ yr^{-1}; $Rb^{87}=0.283$ g Rb^{87} per g Rb.

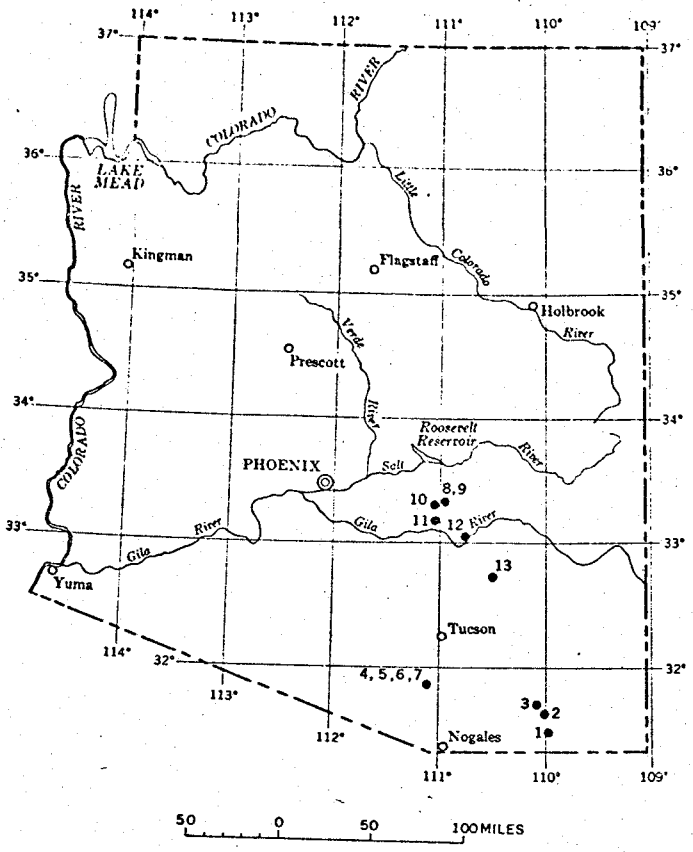


FIGURE 120.1.—Index map of Arizona showing location of igneous rocks sampled for the isotopic age determinations listed in table 120.1.

mass spectrometer by the geochronology group of the University of California, Berkeley. Rubidium and strontium were determined by isotope dilution techniques described by Goldich and others (1961, p. 8–35). The analytical determination of potassium and the mass spectrometric measurements of Ar, Rb, and Sr are accurate to about 2 percent. The probable error of an individual mineral age is about ±4 percent.

Most of the intrusive rocks are related spatially either to ore deposits or to structures. These dates are a start toward establishing the age of mineralization of the porphyry copper and other deposits. In the following, the ages of the igneous rock will be discussed briefly in relation to the ore deposits of four general areas, each including one or more mining districts.

WARREN (BISBEE) AND TOMBSTONE DISTRICTS

Three intrusive rocks from the Warren and Tombstone districts were dated: The Juniper Flat Granite from the northern end of the Mule Mountains, intrusive rhyolite from south of Tombstone, and the Schieffelin Granodiorite from Tombstone. Gilluly (1956, p. 55) determined the age of the Juniper Flat Granite to be post-Pennsylvanian (Horquilla Limestone) and pre-Lower Cretaceous (Bisbee Group). He also assigned a tentative Tertiary age to the intrusive rhyolite south of Tombstone on indirect geologic evidence (Gilluly, 1956, p. 106) and correlated it with the granite porphyry mapped by Ransome (1904) in the Warren district. The similarity in chemical composition of the intrusive rhyolite and the granite porphyry supports this correlation: both have an unusually high K_2O content. This correlation could not be tested by isotopic dating, however, for we were not able to obtain granite porphyry with fresh biotite.

Ransome (1904, p. 84) thought that the granite porphyry, the Juniper Flat Granite, and the Sacramento Porphyry (which is the host for disseminated copper ore at Bisbee) were comagmatic. Because the Juniper Flat Granite and the granite porphyry apparently had supplied pebbles to the basal conglomerate of the Bisbee Group of Early Cretaceous age, he assigned the entire rock suite and the ore deposits to the pre-Lower Cretaceous. Others, however, such as Tenney (1935, p. 225–227), believed that the Sacramento Porphyry and the spatially related ore deposits at Bisbee are Late Cretaceous or early Tertiary (Laramide).

The isotopic dating of the Juniper Flat Granite and the intrusive rhyolite do not establish the age of the Bisbee ore deposits. However, they do support Gilluly's conclusions that both Cenozoic and Mesozoic granitic rocks occur in the Bisbee area, that the apparent time interval between them is about 100 m.y. (million years), and that the deposits at Bisbee probably are related in time to only one of these.

Bain (1952), using the Pb^{207}/Pb^{206} ratio of uraninite from veins in the Bisbee district, suggested that the age of the Bisbee ore is 85 to 112 m.y. The radiogenic components of lead in the uraninites were small, however, and isotopic analyses of lead in the samples were not internally consistent. Under such conditions an unequivocal age determination is most difficult. Our data neither confirm nor contradict Bain's determinations.

The Schieffelin Granodiorite is the rock unit most closely related in time and space to the ore deposits at Tombstone (Gilluly, 1956, p. 160). The geologic age of the Schieffelin Granodiorite is post-Bronco Volcanics, which rests on the eroded surface of the Bisbee Group (Gilluly, 1956, p. 87). The isotopic age seems compatible with the position of the Schieffelin Granodiorite in the geologic sequence, and, as a working hypothesis, 72 m.y. can be used as the maximum age of the ore deposits at Tombstone.

The Schieffelin Granodiorite is younger than thrust faults in the Tombstone Hills. The age of the Schief-

elin therefore establishes a minimum age of 72 m.y. for the thrusts.

PIMA DISTRICT

K-Ar ages were determined for four igneous rocks from the Pima district: equigranular granodiorite, quartz monzonite porphyry, rhyolite tuff, and andesite dikes. These rocks and their general relations to each other, to the ore deposits, and to the structures in the area have been described by Cooper (1960, p. 72, 74, 76, and 89).

After a major orogeny that formed highly complex northwest-trending fault and fold structures in sedimentary and volcanic rocks of Cretaceous(?) age, the granodiorite and quartz monzonite porphyry were intruded. Although the geologic evidence is not unequivocal, Cooper (1960, p. 74) thought the granodiorite was older, but he gave no impression of a significant time break between the two intrusives. Cooper's views are supported by the K-Ar ages of the two rocks. According to Cooper (1960, p. 63) the quartz monzonite porphyry is spatially associated with ore deposits in the Pima district, and possibly is genetically related to them. This possible genetic relation, however, is indirect because the porphyry itself is the host for the disseminated copper ore. The K-Ar age of very slightly mineralized porphyry, 56 m.y., establishes a maximum age for the ore.

According to Cooper (1960), the Helmet Fanglomerate is younger than the ore deposits, and is cut by a large thrust (San Xavier thrust) which also is younger than the ore deposits. Both the San Xavier thrust and the Helmet Fanglomerate are transected by a narrow zone of andesite dikes. The K-Ar age of the andesite dikes establishes a minimum age for the thrusting and ore deposition.

The K-Ar dates give some information on the apparent ages of structural events in the Pima district. Here, thrusts and folds are older than 60 m.y., the age of the granodiorite, whereas in the Tombstone district, thrusts are older than 72 m.y., the age of the Schieffelin Granodiorite. A Late Cretaceous-early Tertiary period of deformation that includes thrusting long has been postulated for southeastern Arizona, and these apparent dates help to define it. In addition, Cooper (1960) recognized the San Xavier thrust in the Pima district as being a distinctly younger and independent structure. The age of the andesite dikes (24 m.y.) established a significant younger age limit for this thrust. Unfortunately a reliable older age limit was not obtained. The rhyolite tuff, which is older than the Helmet Fanglomerate, was dated with the hope that it, along with the andesite dikes, would bracket the Helmet Fanglomerate and San Xavier fault within a small time span. The K-Ar age of the rhyolite tuff is virtually the same as that of the quartz monzonite porphyry, thus the time interval between the apparent maximum and minimum ages for the Helmet Fanglomerate and the San Xavier thrust is 32 m.y., a figure much larger than we anticipated. The similarity of the K-Ar ages of the quartz monzonite porphyry and rhyolite tuff, however, raises the problem of a possible genetic relation between the two.

The K-Ar ages of the four rocks in the Pima district suggest the following sequence of events:

1. Deformation intensely folded and faulted the volcanic and sedimentary rocks over 60 m.y. ago.
2. The quartz monzonite porphyry was mineralized no earlier than 56 m.y. ago.
3. The deposition of the Helmet Fanglomerate and the movement along the San Xavier thrust occurred less than 56 to 57 m.y. ago (the K-Ar ages of the quartz monzonite porphyry and the rhyolite tuff), and more than 24 m.y. ago (the K-Ar ages of the andesite dikes).

GLOBE-MIAMI DISTRICT

The Lost Gulch Quartz Monzonite and the Schultze Granite from the Globe-Miami district were dated by the K-Ar method. The Lost Gulch Quartz Monzonite is the host rock for the Castle Dome and Copper Cities disseminated copper deposits. Locally the Schultze Granite is also mineralized.

The Lost Gulch Quartz Monzonite is known to be post-Paleozoic, but there are no Mesozoic rocks in the area by which its age relative to that era can be determined. It is cut by granite porphyry that seems to be genetically related to the Schultze Granite, and on this basis the Schultze Granite was thought by Peterson (1954) to be younger. Peterson (1954) thought the extensive copper mineralization in the Globe-Miami district closely followed the intrusion of the Schultze Granite and granite porphyry and was the culminating event in the long period of igneous activity. The close spatial relation of the Lost Gulch Quartz Monzonite and Schultze Granite supports the close isotopic ages and, indirectly therefore, the general time of the igneous activity in the Globe-Miami district. Until further information on the age of the deposits is available, a tentative maximum age of 58 m.y. for the disseminated copper deposits seems reasonable.

In the Globe-Miami district, a large ash-flow deposit of post-mineralization dacite accumulated on a well-developed erosion surface. Here and there as much as several hundred feet of conglomerate (Whitetail Conglomerate) separates the dacite from the under-

lying rocks. The K-Ar age of the vitrophyre at the base of the dacite is 20 m.y. This age for the "cover rocks" is a minimum for the copper mineralization in the Globe-Miami district. Secondary enrichment in the Miami-Inspiration ore body is related to topography that antedates the Whitetail Conglomerate (Ransome, 1919, p. 173–174), which suggests that the ore is considerably older than the dacite.

MINERAL CREEK, BANNER, AND BUNKER HILL DISTRICTS

The Granite Mountain Porphyry from Ray (Mineral Creek district), the quartz diorite porphyry from Christmas (Banner district), and the granodiorite from Copper Creek (Bunker Hill district) were dated by the K-Ar method. These three districts are separated by about 40 airline miles, Christmas being roughly 15 airline miles southeast of Ray, and Copper Creek roughly 25 airline miles southeast of Christmas (fig. 120.1).

At Ray, the Granite Mountain Porphyry forms part of the disseminated copper deposit. At Christmas, pyrometasomatic copper deposits formed along the intrusive contacts of the quartz diorite porphyry and certain carbonate beds in the Paleozoic section, and at Copper Creek, the granodiorite is the host rock for perhaps 25 to 50 breccia pipes, many of which are mineralized.

The Granite Mountain Porphyry cuts only the Precambrian Pinal Schist, so that its age relative to younger rocks is indeterminate. Both the quartz diorite porphyry at Christmas and the granodiorite at Copper Creek intrude andesitic volcanic rocks. According to Frank Simons (written communication, 1962), the andesites intruded by the granodiorite appear to overlie unconformably a sequence of conglomerate and shale that he has correlated tentatively with the Pinkard Formation of Late Cretaceous age. Holmes (1960) dates the end of the Cretaceous at 70±2 m.y. The isotopic ages of the quartz diorite porphyry at Christmas and the granodiorite at Copper Creek do not conflict with their ages as determined by their relation to other rocks, some of which have been dated by fossils, and until further information is available 62 and 68 m.y. are reasonable assumptions for the maximum age of the ore deposits at Christmas and Copper Creek respectively.

The K-Ar age of 63 m.y. for the Granite Mountain Porphyry is close to that of the quartz diorite porphyry at Christmas, the Schultze Granite, and the Lost Gulch Quartz Monzonite. Ransome's (1919, p. 67) geologic studies indicated a close genetic relation between the quartzose granitic rocks in the Globe-Miami, Ray, and Christmas areas. A close genetic relation implies a close time relation. On this basis, the K-Ar age of the Granite Mountain Porphyry is compatible with Ransome's geologic interpretations.

TABLE 120.2.—*Apparent maximum and minimum age of ore deposits in six mining districts in Arizona, based on K-Ar age of biotites in associated intrusive rocks*

Mining district	Rock	Maximum age (million years)	Minimum age (million years)
Tombstone	Schieffelin Granodiorite	72	
Pima	Quartz monzonite porphyry.	56	24
Globe-Miami	Schultze Granite	58	20
Mineral Creek	Granite Mountain Porphyry.	63	
Bunker Hill	Granodiorite at Copper Creek.	68	
Banner	Quartz diorite porphyry at Christmas.	62	
Average			63
Mean			62–63
Range			16

The apparent maximum and minimum age of ore deposits in the six mining districts based on the K-Ar age of biotites in the associated intrusive igneous rocks ("porphyries") are summarized in table 120.2. The significance that one attributes to the ages in the table depends on the extent to which one accepts a close time and genetic relation between the "porphyries" and the ore. In writing about the deposits at Ray and Miami 43 years ago, Ransome (1919, p. 166) lucidly stated the position of those of us who accept a close tie, but not a direct one:

> Had no previous study been made of the copper deposits of the western United States and were observation restricted to one only of the two districts here described, the observer might well inquire whether the association of the ores with granitic or monzonitic porphyry is merely accidental or is an illustration of cause and effect. The present state of our information, however, leaves little room for this doubt. Not only at Ray and Miami but at Clifton, Bisbee, and Ajo in Arizona, at Ely in Nevada, at Santa Rita in New Mexico, and at Bingham in Utah, not to mention occurrences outside of this country, copper ores generally similar to those of Ray and Miami are closely associated with monzonite porphyry or with porphyry intermediate in character between monzonite porphyry and granite porphyry. In some of these districts the evidence for an essential genetic relationship between ore and porphyry is plain: in others it is more or less equivocal to anyone who permits himself to realize that some ores, even ores of copper, may occur in localities where there is nothing to suggest any connection between them and igneous activity. Taken collectively, however, the disseminated copper deposits of the southwestern United States present convincing evidence that the monzonitic porphyries, by which they are invariably accompanied, had something to do with their origin.
>
> It is not to be supposed, however, that the now visible parts of these bodies of porphyry contributed in any active way to

...y deposition. They, like the neighboring schist, have themselves been altered by the ore-bearing solutions, and, where favorably situated, have been changed into protore just as the schist was changed under similar circumstances. Their significance lies in their testimony to the probable presence of larger masses of similar igneous material below any depths likely to be reached in mining, and it is from these larger and deeper masses, which must have taken far longer to solidify and cool than the bodies now exposed by natural erosion and in the mines, that most of the energy and at least a part of the materials were derived to form the protore.

Following Ransome's beliefs, the data presented here suggest that the range in age of the ore deposits is essentially the range in K-Ar age of the "porphyries," that is, 56 to 72 m.y. On the Holmes (1960) time scale, the Cretaceous period ended 70±2 m.y. ago and the Eocene 40 m.y. ago. Using these terminal dates, the ore deposits are early Tertiary, and the range in time of 16 m.y. seems small to us. We find considerable support in the data for the concept of a Laramide period of mineralization in southeastern Arizona.

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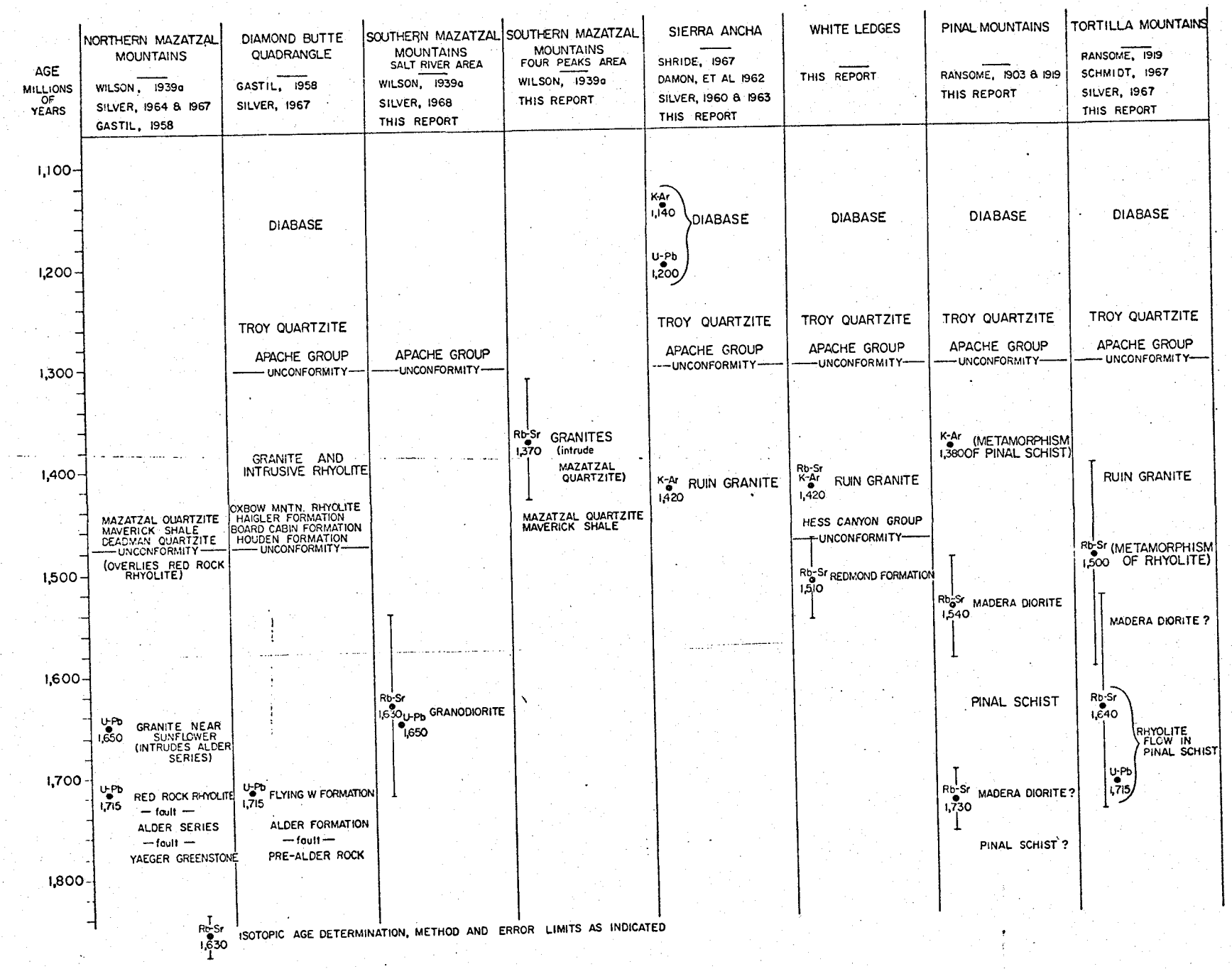
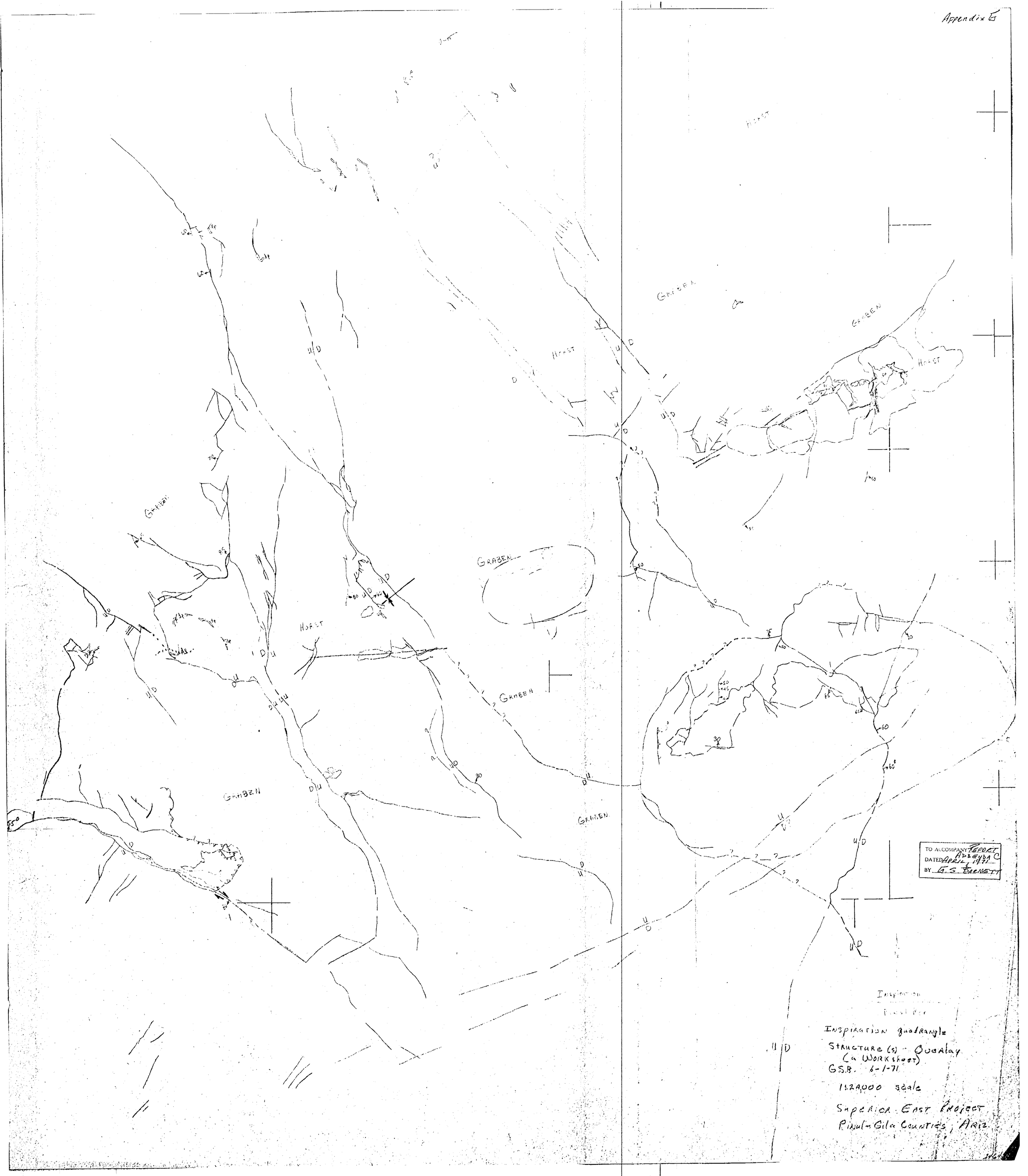
FIGURE 21- CORRELATION OF PRECAMBRIAN FORMATIONS IN CENTRAL ARIZONA

D. E. LIVINGSTON, 1969



Appendix E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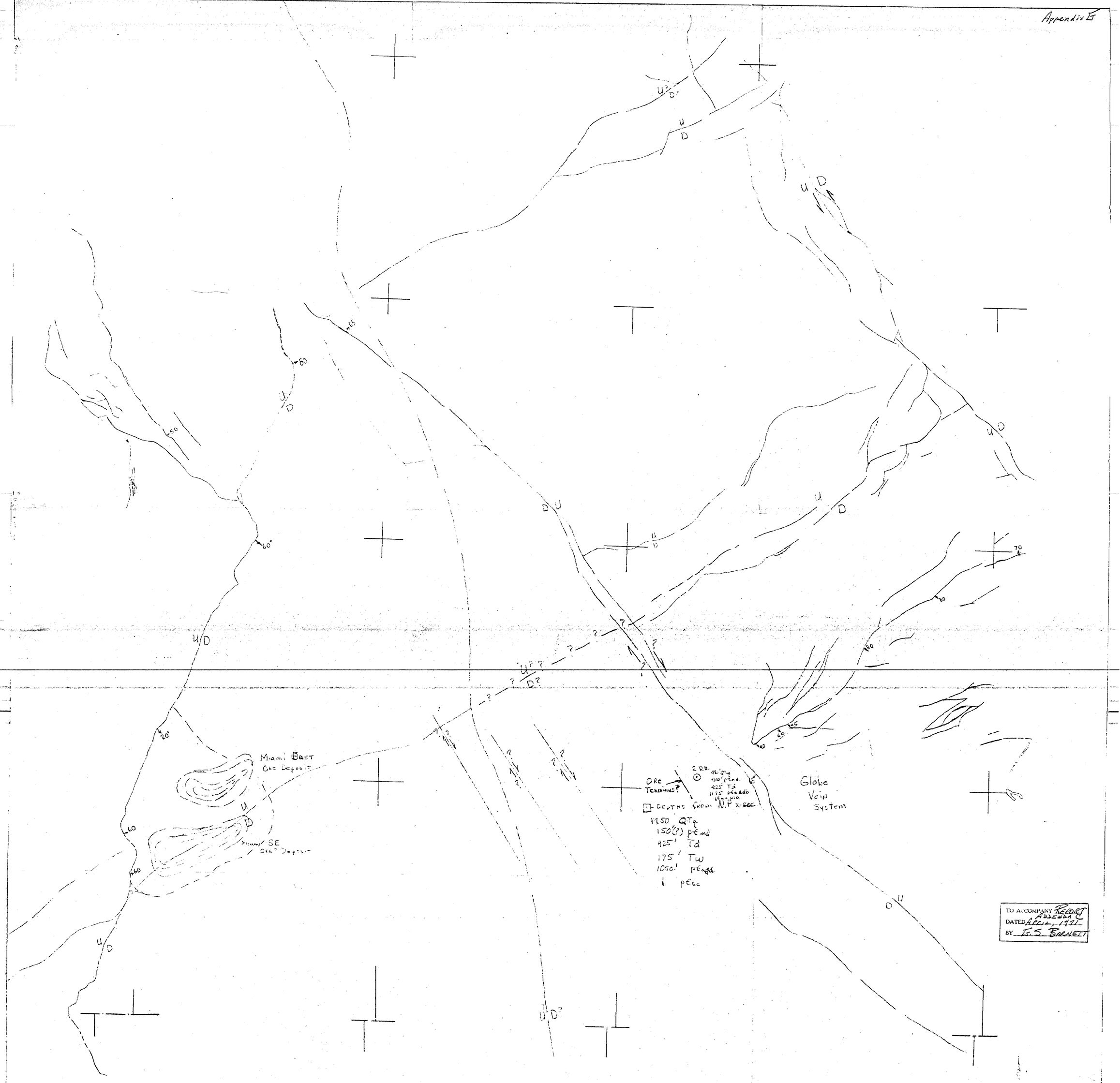
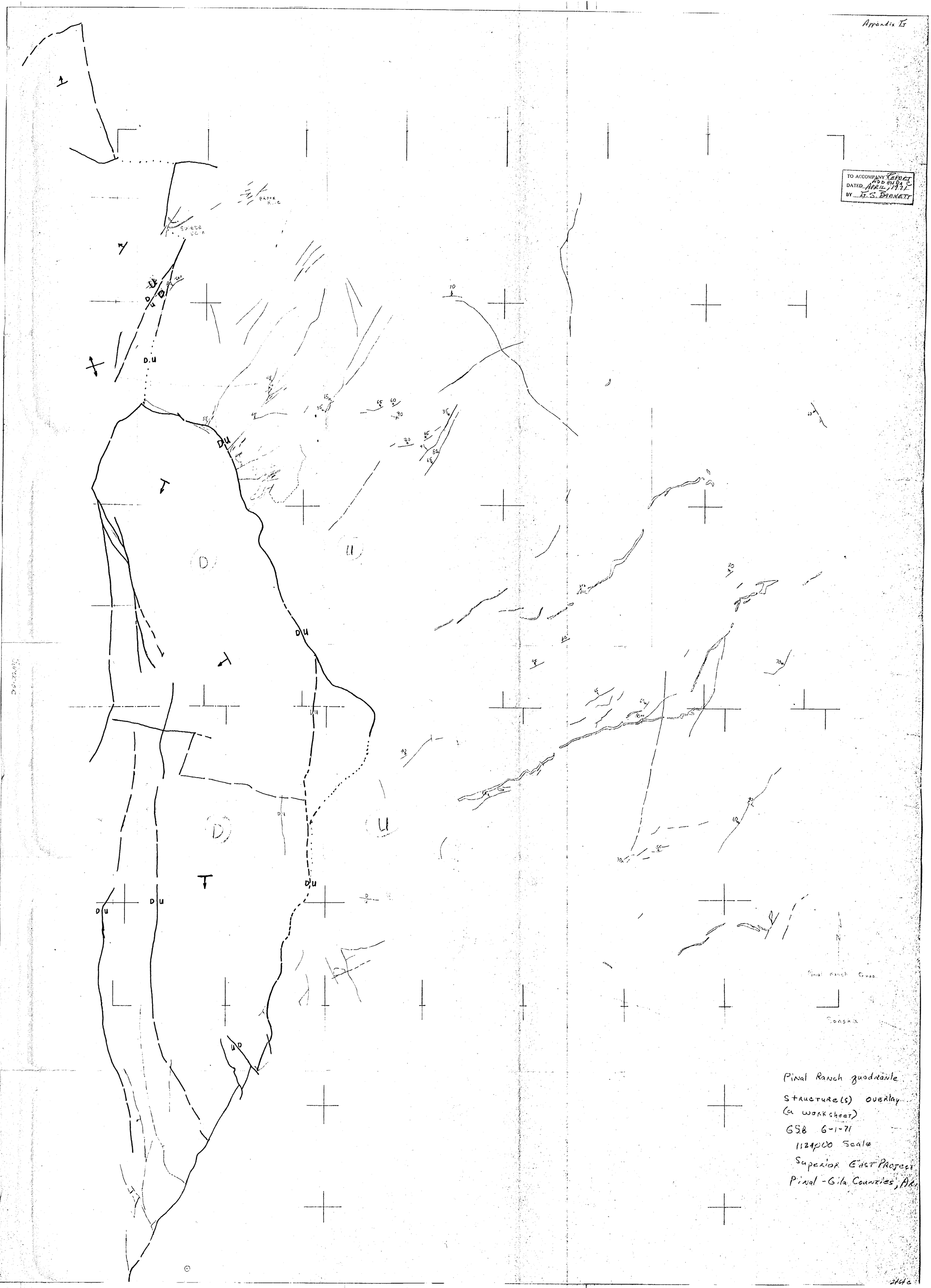
TO ACCOMPANY REPORT
DATED APRIL 1971 ADDENDA C
BY G.S. BARNETT
INSPIRATION
INSPIRATION quadrangle
STRUCTURE (S) - QUCALAY
(a WORKSHEET)
G.S.B. 6-1-71
1:24,000 scale
SUPERIOR EAST PROJECT
PINAL-GILA COUNTIES, ARIZ.

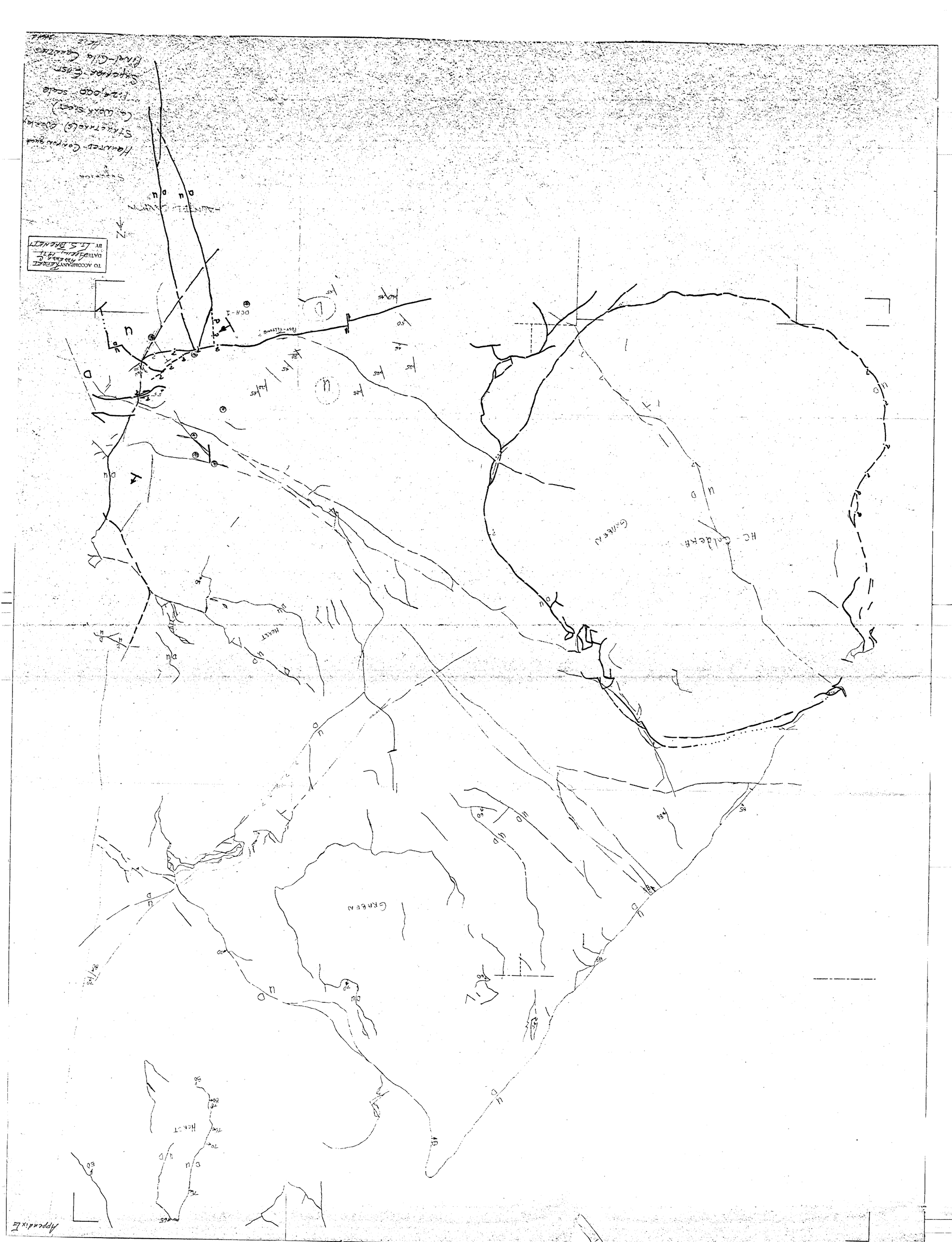
Appendix B



Globe Quadrangle
Structure(s) — Overlay
(a. Worksheet
G.S.B. 6-1-71
1:24000 scale
Superior East Project
Pinal-Gila Counties, Ariz.

Appendix I


TO ACCOMPANY REPORT ADDENDUM C
DATED APRIL, 1971
BY F.S. BARNETT
D.U
D
U
Pinal Ranch Group
Sonsela
Pinal Ranch quadrangle
structure(s) overlay
(a worksheet)
GSB 6-1-71
1:24,000 Scale
Superior East Project
Pinal-Gila Counties, Ariz.


Appendix E
Hanaret-Gonzales Area
Structure(s) Cross Section
(w. Work Sheet)
1:24,000 Scale
Superior-Esco
Final-Gila Geotecs
July 2004
TO ACCOMPANY REPORT
DATED April 12th
BY L.S. Brennit
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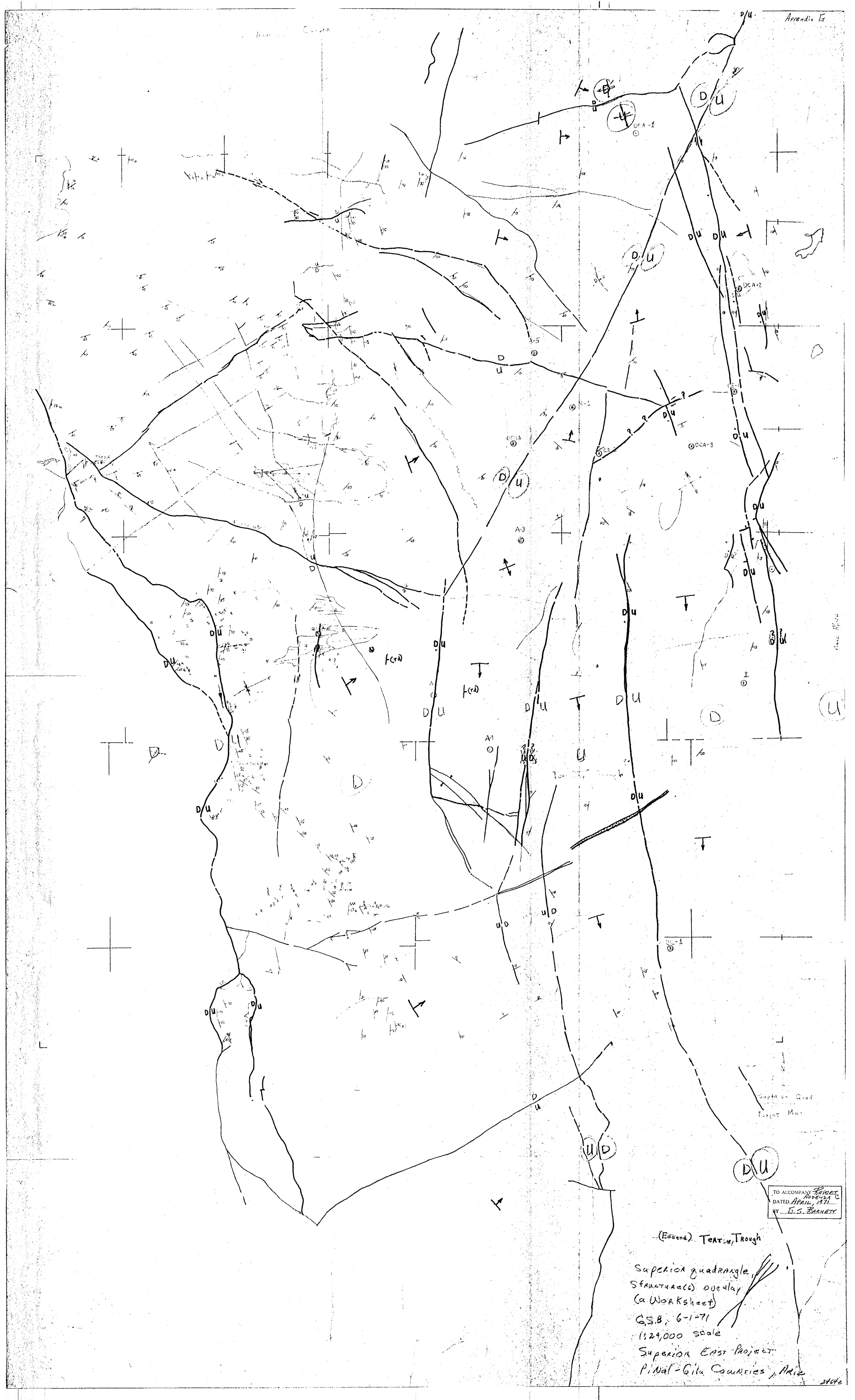
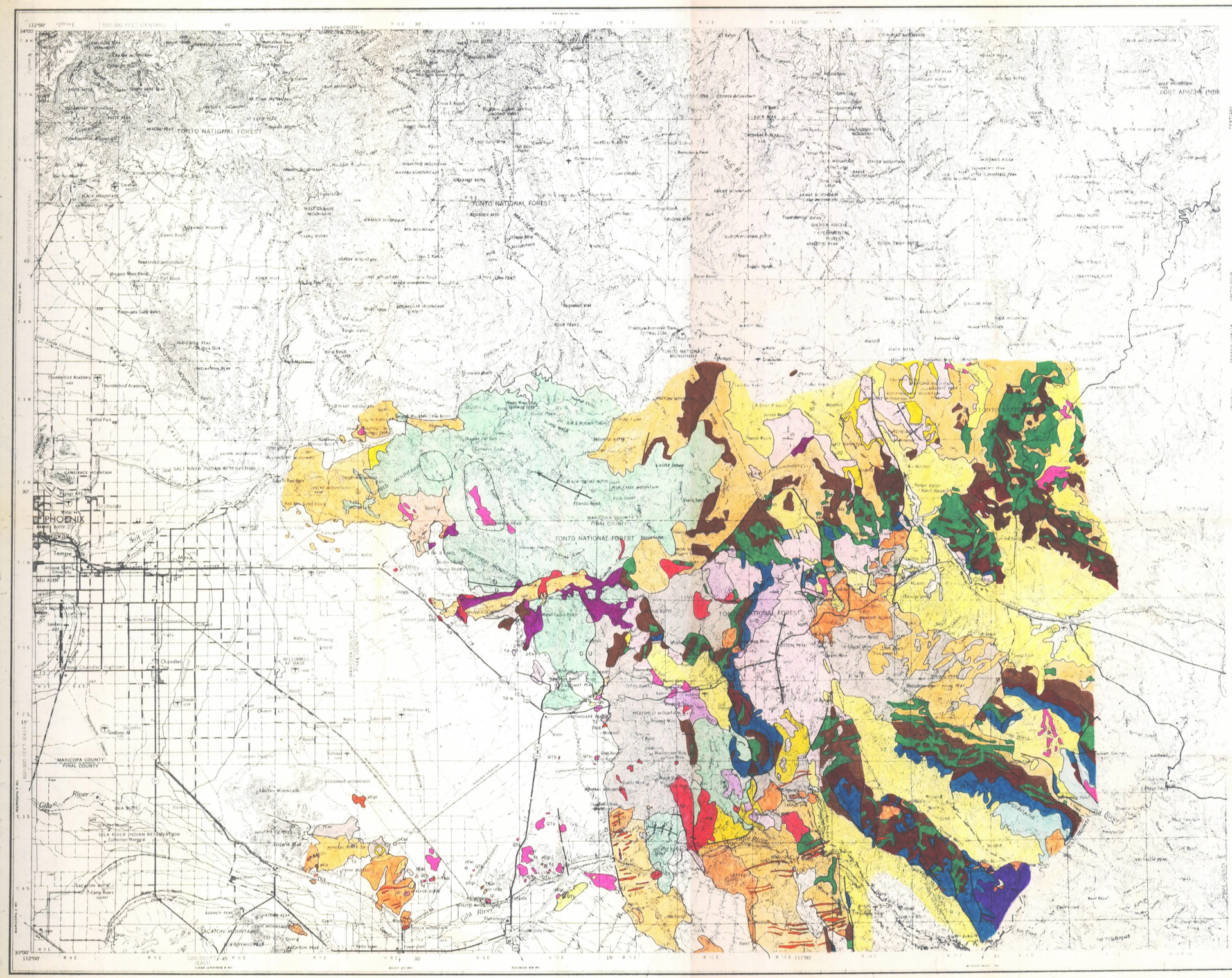
HC - Colada KA
Graben
Hanaret
DCH-1
Fault-Filling?


Appendix F
DCA-1
DCA-2
DCA-3
A-1
A-3
A-5
(Eocene) Tertiary Trough
Superior quadrangle,
Structure(s) overlay
(a Worksheet)
G.S.B., 6-1-71
1:24,000 scale
Superior East Project
Pinal-Gila Counties, Ariz
TO ACCOMPANY REPORT ADDENDA C
DATED APRIL, 1971
BY G.S. BARNETT



EXPLANATION

ATTACHMENT F

QUATERNARY

Qal — SEDIMENTARY DEPOSITS—mainly alluvial gravel, sand, and silt in flood plains, terraces, fans, and pediment coverings.

TERTIARY TO QUATERNARY

QTg — GILA CONGLOMERATE and other stream and lake deposits in intermontane areas. Consists of loosely to firmly consolidated gravel, sand and silt, local clay, gypsum, marl, limestone, diatomite and some intercalcated basalt flows and felsic tuff beds.

QTb — VOLCANIC ROCKS—basaltic flows, agglomerate, tuffs, and cinders distinguished from older basalts by recognizable cinder cones, calderas and other geomorphic evidence of youth. However, some basalts or basaltic andesites included here may actually be of Tertiary age.

QTs — VOLCANIC ROCKS—includes units interfingering with QTs and possibly older units whose debris is in QTg. Basaltic flows, agglomerate, tuff, and cinders.

TERTIARY

Td, Tvc, Tr — VOLCANIC ROCKS—volcanic complexes, calderas, flows, tuffs, breccias and agglomerates interfingering in part with Tertiary sedimentary rocks. Includes plugs and dikes of mafic to silicic composition. Td—DACITE—quartz latitic, welded to partly welded ash-flow tuffs of 20 m.y. in the Superior area. Tr—VOLCANIC ROCKS—predominantly rhyolitic but including basalts or basaltic andesites in the lower part of the section. Tv—ANDESITE—basaltic andesites or basalts as flows, vents, agglomerates, etc.

Tw — WHITETAIL CONGLOMERATE or approximate equivalents. Terrestrial conglomerate, sandstone, siltstone, limestone, tuffaceous beds. Generally lacking volcanic clasts always lacking DACITE clasts.

Tks — SEDIMENTARY ROCKS—coarse conglomerate, shale, sandstone generally deposited on basement rocks, particularly schist.

TKv — VOLCANIC ROCKS—includes flows, pyroclastic rocks and associated conglomerates consisting largely of volcanic debris. Where in contact with penecontemporaneous intrusive rocks (TKg, TKd, TKi), the intrusive rocks generally cut the volcanic rocks. Predominantly andesitic in composition.

CRETACEOUS TO TERTIARY OR LARAMIDE

TKg, TKd, TKi — INTRUSIVE ROCKS—TKg—granite, quartz monzonite, granodiorite, quartz diorite, and porphyritic equivalents of these rocks. TKd—diorite to quartz diorite. TKi—granitic, dioritic, rhyolitic, and andesitic dikes, sills, and plugs.

PENNSYLVANIAN AND PERMIAN

PPNc — NACO FORMATION. Lower part of Naco group thin-bedded cherty limestone, shale, sandstone.

DEVONIAN AND MISSISSIPPIAN

DMm — SEDIMENTARY ROCKS—Escabrosa Limestone (Upper and Lower Mbs.) and Martin Formation (Devonian).

YOUNGER PRECAMBRIAN

Qd — DIKES AND PLUGS—mainly basaltic in composition.

Pd — DIKES, SILLS AND PLUGS—mainly basaltic in composition.

Pr — DIKES, SILLS, AND PLUGS—rhyolitic to basaltic in composition.

Pdi — DIABASE—locally includes post-Precambrian diabase (dated in the Sierra Ancha Mts. as ± 1140 m.y.).

Pt — TROY QUARTZITE—locally may contain Cambrian sandstone and quartzite.

Pa — APACHE GROUP—includes Mescal Limestone and associated basalt flows, Dripping Spring Quartzite, and Pioneer Shale.

pCgr — INTRUSIVE ROCKS—granite, quartz monzonite, granodiorite, and quartz diorite. Locally includes pieces of granitic rocks and other igneous rocks of post-Paleozoic age. (Runkle Granite dated at ± 1450 m.y.)

OLDER PRECAMBRIAN

pCsr, pCvr — METAMORPHOSED SEDIMENTARY AND VOLCANIC ROCKS—mainly phyllite, slate, micaschist, chlorite schist, and amphibolite derived from interbedded shale, sandstone, and rhyolitic to basaltic flows and tuffs but locally includes intrusive rhyolite, diorite, gabbro, and pyroxenite.

STRUCTURAL SYMBOLS

Calderas: known; inferred

Faults (dashed where inferred): low-angle; high-angle

homocline; plunging syncline

TO ACCOMPANY ~~REPORT~~ APPENDIX F
DATED AUG., 1971
BY G.S. BARNETT

REGIONAL GEOLOGIC MAP

SUPERIOR EAST PROJECT

Globe–Superior District

PINAL, GILA, & MARICOPA COUNTIES, ARIZONA

Scale: 1" = 4 miles (approx.)

G.S.B. August, 1971

(After Geologic Map of Arizona & County Geologic Map Series)

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