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FORM SL-1035-A 1 M 4-70

JHC

KEEP THIS ON TOP

File No.

From to

Subject: LARAMIDE-PRECAMBRIAN INTRUSIVES

Copy for JHC.

Circulate to Geologists

as usual Asarco geologists trained under Courtright and Richards have called a "granite" the "right granite".

W. L. K.

JUN 20 1972

W. L. K.
JUN 20 1972

J. H. C.
JUN 21 1972

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona

May 11, 1972

file
Laramide - Pre Є Intrusions

TO: W. L. Kurtz

FROM: J. C. Balla

Distinguishing Different Age
Igneous Rocks in the Field

Introduction

One of the questions I was asked to answer by W. E. Saegart as part of my dissertation work was in regard to distinguishing Laramide age igneous rocks from Precambrian age igneous rocks in the field. The question was whether the criteria used by ASARCO geologists in determining Laramide vs. Precambrian age were valid. Subsequent isotopic dating has shown that, in all but one case, the field determination of age was indeed valid.

Based upon the isotopic dating, it appears possible to distinguish in the field the correct age of each period of magmatic activity in Arizona, with a partial reservation between the Laramide and Mid-Tertiary.

The following criteria listed for each rock are sufficiently diagnostic that, in the vast majority of cases, one can feel reasonably confident that the age designation is correct. As always, poor outcrops or limited outcrops may make any designation questionable.

It should also be mentioned that the depth of erosion is quite important. Whether one is looking at the top of a stock or deep into the interior makes a profound difference between the characteristics of each "level" of the stock.

Attached to the report is a series of maps showing "type localities" for the different age rocks.

Older Precambrian

Madera Diorite and its Equivalents

The isotopic age is approximately 1630 m.y., but the San Tan Quartz Monzonite and Table Top Quartz Monzonite (considered to be equivalent to the Madera) yield isotopic ages of 1341 m.y. and 1329 m.y., respectively.

This rock varies in composition from a quartz monzonite to a diorite. It seems to have gradational contacts between these different rock types, in the same stock. The rock is medium grained, equigranular, non-porphyritic. Epidote is very common, occuring on fracture planes and disseminated (derived from alteration of the mafics). Biotite has been altered (generally) to chlorite and epidote. Commonly the biotite is "clotty" and appears sheared, as opposed to fresh, shiny books.

The rock intrudes only the Pinal Schist, and may contain numerous xenoliths of Pinal Schist. The rock generally has a crude foliation.

These age rocks occur as small (1000-2000 feet) to medium size (5-10 miles) stocks. The stocks are generally quite elongate.

Oracle - Ruin Granites

This rock yields an isotopic age of 1420 m.y., although a sample from the Sacaton Mountains produced a 1240 m.y. age. This rock is normally called a granite, although compositionally it is a quartz monzonite. These granites are coarse grained, and porphyritic. A very diagnostic feature are the phenocrysts, which are very large pink K-feldspar. The K-feldspar occurs up to 3-4 inches in length. Plagioclase occurs as anhedral to subhedral grains. Biotite has been altered to chlorite, and is "clotty" in appearance.

The rock is generally non-foliated. It may or may not contain aplite dikes. It also may or may not contain roof pendants of Pinal Schist.

These granites occur as very large batholithic masses. In some cases an entire mountain range may be composed of this rock. The dimensions of these batholiths are unknown, but the Oracle batholith appears to be at least 50 miles across.

Younger Precambrian

Solitude - Sacaton Granites

These rocks are distinctive, and their Younger Precambrian age is a relatively new discovery. The Sacaton Granite has an isotopic age of 857 m.y., and the Solitude Granite has an apparent isotopic age of 800-900 m.y.

These rocks are fine to medium grained, equigranular, non-porphyritic granites. Particularly diagnostic is the presence of muscovite. Biotite may also be present, making a "Two-Mica Granite". So far as known, the rock has never been found intruding the Apache Group sediments.

The rock occurs as small stocks, with the average dimensions being about a mile in diameter.

Laramide

The Laramide rocks are broken into two general categories, the Granitic stocks and the Quartz Diorite-Diorite stocks.

Granitic Stocks

These rocks range in isotopic age from about 70 m.y. to 52 m.y., with the older stocks being in the western part of the State. These rocks range in composition from a granodiorite to a granite, with most falling in the quartz monzonite-granodiorite range.

These granitic stocks are elongate, composite, epizonal plutons. They may have one, two, or three different facies present. The presence or absence of these different facies is due to the "level" or depth position of the stock that we presently observe, and the magmatic history of the rock. The contact zone between these different facies may be sharp (perhaps 10 feet or less) or gradational (hundreds of feet). It should be emphasized that different Laramide rocks which are adjacent to each other may only represent different facies of the same stock, and that these different facies should be mapped.

These stocks range in size from small stocks (several thousand feet in diameter) to very large stocks, occupying 20 square miles or more.

The Laramide age granitic stocks have the widest range of characteristics. There does not appear to be any single characteristic that distinguishes these rocks from other age rocks.

The rocks are generally equigranular, non-porphyritic. However, in the core zone, or observing a deeply eroded stock (Schultze Granite), large (3"-4" in length) phenocrysts of K-feldspar or plagioclase may occur. The phenocrysts are generally white, compared to the Precambrian pink K-feldspar phenocrysts. Quartz may occur as rounded phenocrysts, or as interstitial material.

Biotite has long been used by ASARCO geologists as a diagnostic mineral. If the biotite occurred as euhedral, black to blackish green books, it was considered to be diagnostic of a Laramide stock. In general, this criterion is valid. However, in the core zone of the Laramide stocks, biotite has almost always been altered to chlorite. Also, fresh, unaltered biotite has been found in the Older Precambrian quartz monzonite in the Table Top Mountains. Thus, this particular characteristic must be used with discretion.

The Laramide rocks are generally non-foliated. However, near the contacts with other rocks, the rock may become distinctly foliated. Flow structures appear to be limited to the Laramide rocks, but occur so infrequently that their absence means nothing.

Quartz Diorite - Diorite Stocks

These rocks vary in composition from a diorite to a quartz diorite. They vary in isotopic age from 70 m.y. to 62 m.y. These rocks are medium grained, equigranular, non-porphyritic. They are not composite stocks.

These rocks seem to generally contain a little sulfide mineralization. The mineralization consists of pyrite, which occurs on fractures and/or disseminated. The pyrite appears to be a late magmatic feature, as opposed to a hydrothermal feature.

Copper, as chalcopyrite, is associated with the pyrite. Copper values are generally quite low, around 500 ppm ± 200 ppm. Only two of these stocks approach being an ore deposit (Chivito, Christmas). The overall sulfide content is low, less than 2%.

The stocks are generally small, being less than 5000 feet in diameter.

Mid-Tertiary Granitic Stocks

The Mid-Tertiary stocks range from granites to quartz monzonites. They seem to fall into two general "types", those associated with ash flows and ash falls and calderas, and those not spatially associated with volcanic features. In all probability, the two different types are merely different erosion levels of the same magmatic events.

The stocks associated with volcanic rocks are quite distinctive. These rocks, like the Wood Camp Canyon Quartz Monzonite, are generally quartz monzonite in composition. They are very fine grained, equigranular. They may or may not be porphyritic. Phenocrysts, if present, are quartz. Sanidine may be present, and is diagnostic. Rock may be deuterically altered to clay. Disseminated grains of magnetite and/or pyrite may be common. Mafic mineral, if present, is dark, euhedral, fresh biotite. Miarolitic cavities may be present. The stocks, which are small (2-3 miles in long dimension) may or may not intrude the volcanic pile.

In contrasts to the above are large stocks which have a granitic texture. These stocks, such as the Stronghold Granite (K-Ar age 22 m.y.) are identical to the Laramide granitic stocks. The only way of determining the age of these rocks is by radiometric methods.

John C. Balla

JCB:lad
Attach.

APPENDIX 1

The following is a list of "type localities" for various rock units. The figures are from my dissertation. Thin sections for the rocks are available from George Stathis. Hand specimens are stored in the basement in a box labeled "John Balla Dissertation Rocks".

Age of Rock	Name of Rock	Reference
Older Precambrian	Madera Diorite	USGS P.P. 342
" "	San Tan Quartz Monzonite	Figure A-5
" "	Table Top Quartz Monzonite	Figure A-6
" "	Oracle Granite	USGS P.P. 471
" "	Ruin Granite	USGS P.P. 342
Younger "	Solitude Granite	USGS P.P. 342
" "	Sacaton Granite	Figure A-11
Laramide	Schultze Granite	USGS P.P. 342
"	Core Facies-Granitic Stock	Figure A-10
"	Intermediate Facies-Granitic Stock	Figures A-9, A-14
"	Border Facies-Granitic Stock	Figure A-13, sec. 29, T5S, R7E
"	Quartz Diorite-Diorite Stocks	USGS GQ-1021 Schmidt, E., Dissertation, Tortilla Mountains
Mid-Tertiary	Wood Camp Quartz Monzonite	Figure A-2; USGS GQ-128
" "	Stronghold Granite	USGS P.P. 281

R. 12 E.

T.

1

S.

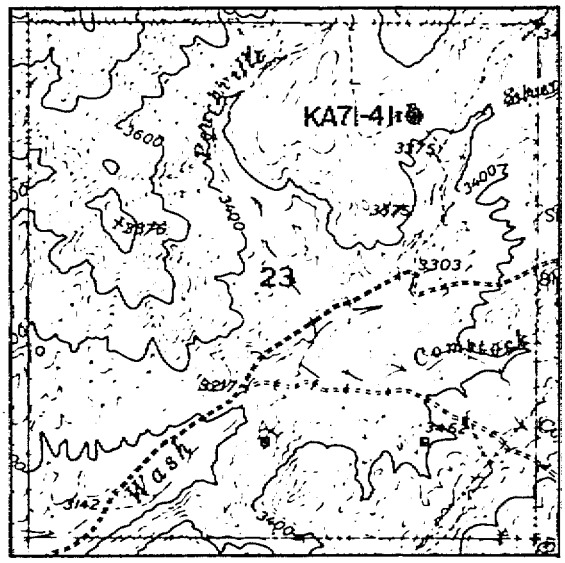

Figure A-1. Location of Sample KA 71-41

R. 12 E.

T.

1

S.

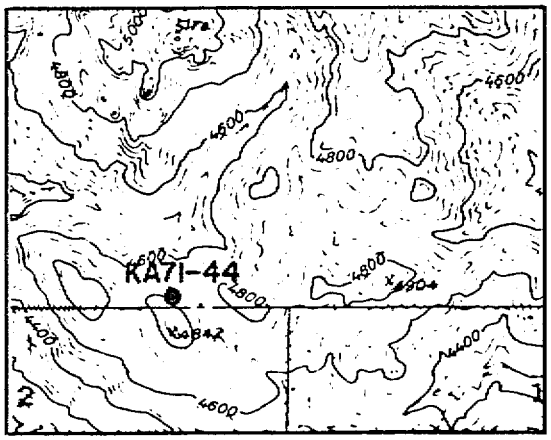

Figure A-2. Location Sample KA 71-44

R. 7 E.

T. 3 S.

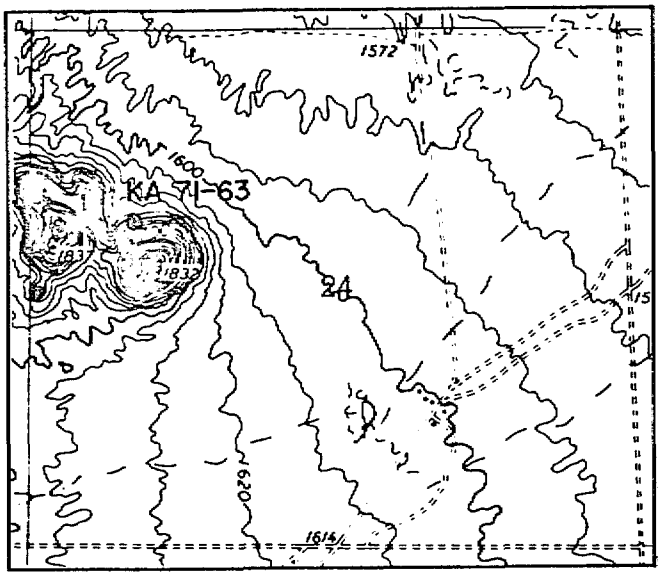

Figure A-5. Location of Sample KA 71-63

R. 2 E.

T. 6 S.

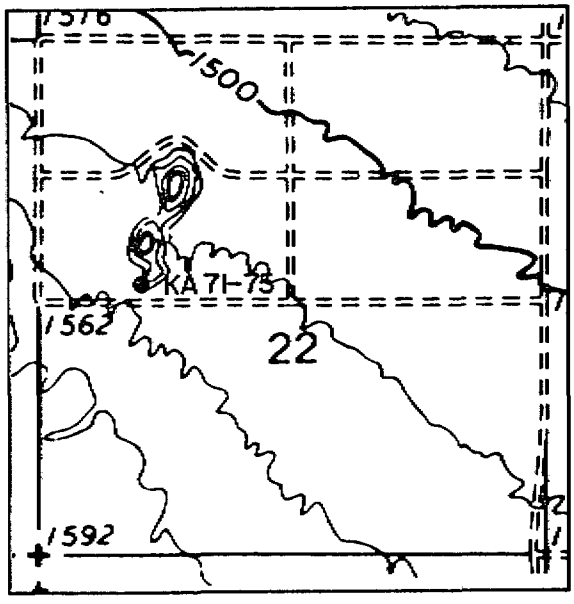

Figure A-6. Location of Sample KA 71-75

R. 7 E.

T.
5
S.

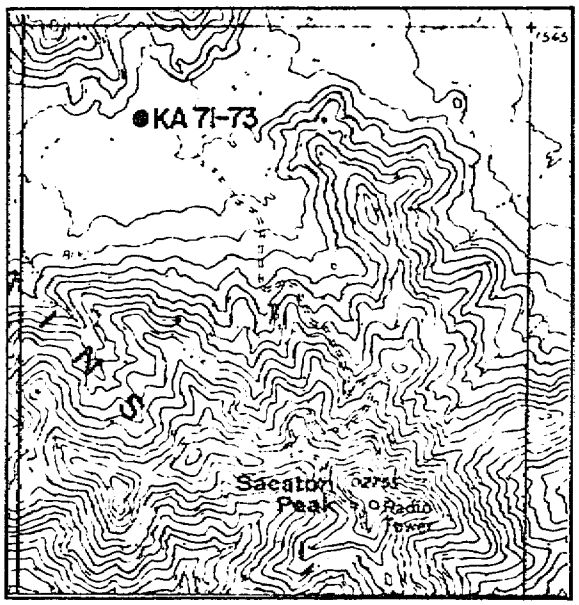

Figure A-9. Location of Sample KA 71-73

R. 6 E.

T.
5
S.

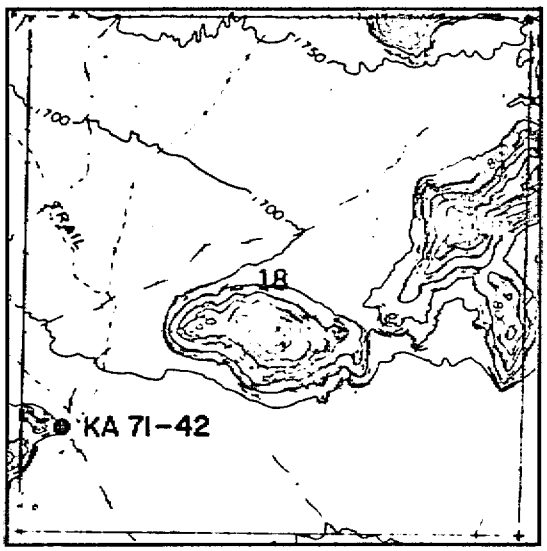

Figure A-10. Location of Sample KA 71-42

R. 5 E.

T.
5
S.

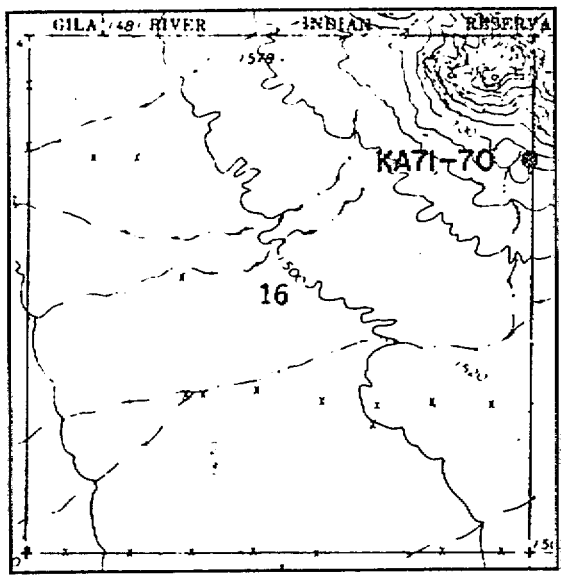

Figure A-11. Location of Sample KA 71-70

R. 5 E.

T.
5
S.

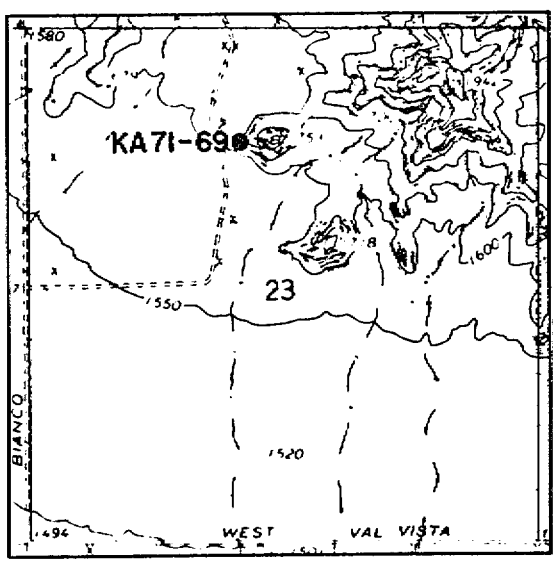

Figure A-12. Location of Sample KA 71-69

R. 8 E.

T.
4
S.

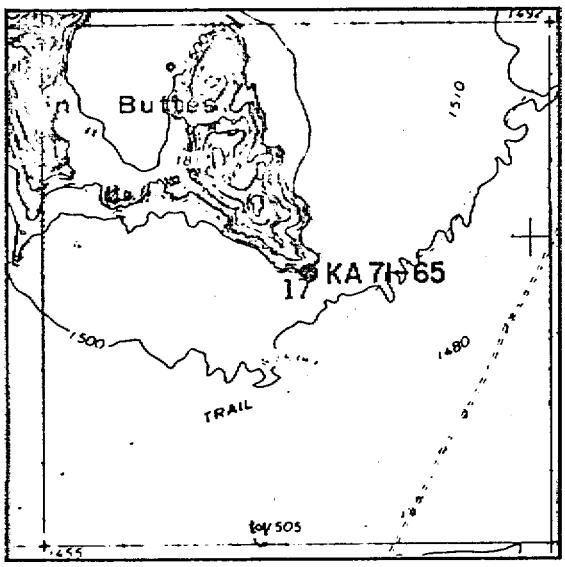

Figure A-13. Location of Sample KA 71-65

R. 8 E.

T.
4
S.

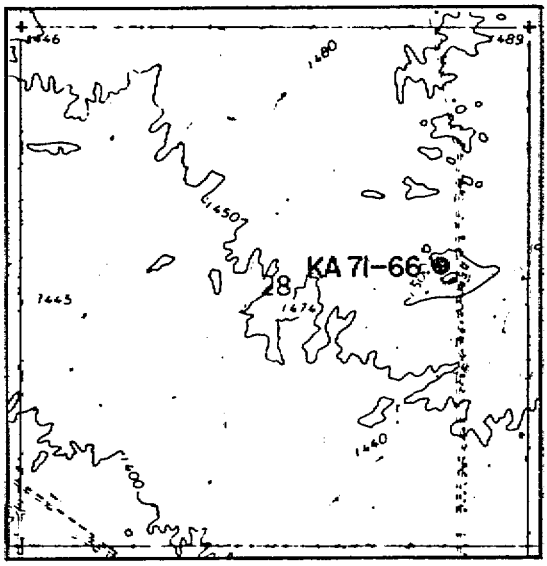

Figure A-14. Location of Sample KA 71-66