Mining Lease

Overview

This section contains the following documents relating to the Mining Lease.

- Lease Assignment assigning 50% of the lease to HeatShield Technologies, Inc. by New Mexico and Arizona Land Company.
- Assignment of Kaolinite Lease to HeatShield Technologies, Inc. by PDC Industrial Coatings, Inc.
- Assignment Agreement assigning 100% of mineral rights to PDC Industrial Coatings, Inc. from Eterna-Tec Corporation.
- Letter from New Mexico and Arizona Land Company stating lease is in good standing and further defines lease rights to include precious metals.
- Original Kaolinite Mining Lease and Agreement.

LEASE ASSIGNMENT

ASSIGNMENT effective this 8th day of October, 1991, among:

PDC INDUSTRIAL COATINGS, INC. ("PDC") Assignor
c/o Paul A. Visosky
Taylor Visosky
#218-470 Granville Street
Vancouver, B.C. V6C 1V5
604-662-8373 phone

HEATSHIELD TECHNOLOGIES, INC. ("Heatshield")
Assignee
c/o Gerald Beyer
Beyer & Dauber
3511 W. Commercial Blvd., Suite 401
Fort Lauderdale, Florida 33309
305-486-7600

NEW MEXICO AND ARIZONA LAND COMPANY ("NZ") Lessor
J.D. Sphar, Vice President-Minerals
6100 Indian School NE, Suite 100
Albuquerque, New Mexico 87110
505-881-6644

1.
RECITAL.

PDC presently holds a kaolinite lease covering on E2SW4 Section 35, T17N, R19W, Mohave County, Arizona, executed on March 30, 1984. NZ is the lessor under that lease. The lease is in good standing. PDC wishes to assign 50% of its interest in this lease to Heatshield. NZ must consent to this assignment for the assignment to be valid.

2.
ASSIGNMENT.

For the consideration of $10.00 and other valuable consideration, the receipt of which is hereby acknowledged, PDC hereby assigns 50% of its interest in the subject lease to Heatshield, together with its rights incident thereto.

CONSENT.

NZ hereby consents to this assignment provided that:

A. LIABILITY. The lessees' obligations and liabilities under the lease shall be joint and several.

B. NOTICE. Lessor's notice to one Lessee shall be considered notice to both lessees. Such notice shall be directed to either or both of the lessees at the addresses noted above, and shall be deemed effective upon mailing, or upon confirmation of electronic transmission.

C. REMAINING LEASE PROVISIONS. All other terms of the original lease are unchanged by this assignment.

Dated: Sep. 26, 1991
PDC INDUSTRIAL COATINGS, INC.

By [signature] PRESIDENT
Its President
John White

Dated: September 16, 1991
HEATSHIELD TECHNOLOGIES, INC.

By [signature]
Its President
Paul R. Arena

Dated: 10/8/91
NEW MEXICO AND ARIZONA LAND COMPANY

By [signature]
Its VP-LAW

P.D.C. INDUSTRIAL COATINGS INC.
Suite 1708 - 1060 Alberni Street
Vancouver, British Columbia
V6E 4K2

September 25, 1991

HeatShield Technologies, Inc.
Suite 316
8400 North University Drive
Tamarac, Florida
33321

Attention: Paul Arena

Dear Sirs:

Assignment of Kaolinite Lease

We refer to the Lease Assignment that we will enter into with you and New Mexico and Arizona Land Company with respect to the transfer of a 50% interest in the lease referred to therein (the "Lease").

We confirm that you will be entering upon the lands demised under the Lease and will be carrying out exploration and development work and mining activities under the terms of the Joint Venture Agreement we entered into with you on May 31, 1991.

We confirm that we have entered into the Lease Assignment on the basis that you covenant and agree with us that:

(a) you will comply, observe and perform all of the covenants and obligations of the lessee under the Lease, jointly and severally with us, from and after the effective date of the Lease Assignment;

(b) the Lease Assignment will be terminated and all right, title and interest in and to the Lease will vest in us on the date that the Joint Venture Agreement is terminated for any reason whatsoever; and

(c) you shall execute such further documentation and perform such other acts as and when may be required to carry out and give full effect to the terms of this letter agreement.

If you are in agreement with the foregoing, please sign in the space below and return a copy of this letter to us by fax.

Yours truly,

P.D.C. INDUSTRIAL COATINGS INC.

per:

JOHN WHITE

The foregoing is hereby acknowledged and agreed to this 30th day of September, 1991.

HEATSHIELD TECHNOLOGIES, INC.

per:

PAUL ARENA

P11.002

WHEN RECORDED, RETURN TO;
GERRIE APKER KURTZ
APKER, APKER, HAGGARD & KURTZ, P.C.
2111 EAST HIGHLAND AVE., SUITE 230
PHOENIX, ARIZONA 85016

PROOFED
INDEX MISCELLANEOUS
INDEXED ASSIGNMENT
INDEXED LEASES

FEE # 89-57976

RECORDED IN OFFICIAL RECORDS OF MOHAVE COUNTY, ARIZONA
NOV 1 '89 -8 00 AM
Joan McCall, County Recorder
FEE 10.00 PGS 1 of 6

RECORDER SEAL MOHAVE COUNTY ARIZONA 1864

ASSIGNMENT AGREEMENT

THIS AGREEMENT made the 26th day of October, 1989

BETWEEN:

ETERNA-TEC CORPORATION, a body corporate incorporated under the laws of the State of Illinois and carrying on business in the States of Illinois and Arizona;

(hereinafter referred to as the "Assignor")

OF THE FIRST PART

AND:

P.D.C. INDUSTRIAL COATINGS INC. (formerly Argonaut Resources Ltd.) a body corporate domesticated under the laws of the State of Delaware and carrying on business in the States of Delaware and Arizona;

(hereinafter referred to as the "Assignee")

OF THE SECOND PART

WHEREAS:

A. The Assignor has entered into a Lease Agreement (the "Lease Agreement") with New Mexico and Arizona Land Company (the "Lessor"), an Arizona corporation dated March 1, 1984; and

B. The Assignor wishes to assign its interest in the Lease Agreement to the Assignee for valuable consideration received by it from the Assignee; and

C. The Assignee wishes to accept the Assignment of the Assignor's interest in the Lease Agreement in exchange for the consideration given;

NOW, THEREFORE, in consideration of the mutual promises and covenants contained herein and for other good and valuable consideration and the payment of $10.00 from each party to the other (the receipt and sufficiency of which is hereby acknowledged) the parties hereto agree as follows:

1. <u>ASSIGNMENT</u>

1.1 <u>Assignment</u>. The Assignor hereby assigns and transfers to the Assignee all of its rights and interest as Lessee under the

Lease Agreement relating to:

The East Half of the Southeast Quarter of Section 35, Township 17 North, Range 19 West, Mohave County, State of Arizona, United Sttes of America.

1.2. The consideration for the assignment of the rights and interest of the Assignor under the Lease Agreement is the issuance by the Assignee of shares of its capital stock to the Assignor pursuant to the terms of an Agreement to Purchase Assets dated September 7, 1988 (as amended).

2. <u>REPRESENTATIONS, WARRANTIES AND COVENANTS</u>

2.1 <u>Representations, Warranties and Covenants by the Assignor</u>. The Assignor covenants with, and represents and warrants to the Assignee, and acknowledges that the Assignee has relied upon such representations, warranties and covenants in entering into this Assignment Agreement as follows:

(a) the Lease Agreement has been validly created and is enforceable and has been validly executed pursuant to the laws of the State of Arizona;

(b) there has been no default under the Lease Agreement and no breach of any of the covenants contained therein and the Assignor has performed all of its obligations and covenants under the Lease Agreement;

(c) the Lease Agreement has not previously been terminated or assigned to any other party prior to the execution of this Assignment Agreement;

(d) there have been no dealings with the property which is the subject of the Lease Agreement which would adversely affect the Assignor's right or title thereto or that would adversely affect the right or title of the Assignee thereto;

(e) the Assignor has informed the Lessor of its intention to assign its interest to the Assignee herein and has received the consent to the assignment by the Lessor pursuant to the terms of the Lease Agreement;

(f) the Assignor has the necessary corporate power and authority to enter into this Agreement; to implement the terms of this Agreement; has the power to execute and deliver the Agreement and that all necessary corporate Resolutions and other necessary documentation have been obtained to give that power and authority;

(g) the Assignor covenants and agrees to indemnify and save harmless the Assignee from all claims, charges or actions of whatsoever nature or kind relating to the performance of the terms of the Lease Agreement where the cause of such action is a result of the actions of the Assignee arising prior to the date of this Assignment Agreement.

2.2 Survival and Indemnity. The representations, warranties and covenants contained in this Assignment Agreement shall survive execution hereof and remain in full force and effect for the benefit of the Assignee. The Assignor hereby covenants to indemnify and save harmless the Assignee from and against any loss, claim, action, liability, damage and cost (including costs on a solicitor and his own client basis) arising from any covenants, representations or warranties of the Assignor set forth in this Assignment Agreement being untrue, incorrect or breached.

2.3 Representations, Warranties and Covenants by the Assignee. The Assignee covenants with and represents and warrants to the Assignor, and acknowledges that the Assignor has relied upon such representations, warranties and covenants in entering into this Assignment Agreement as follows:

(a) the Assignee shall perform all of the obligations of the Lessee under the Lease Agreement from the date of this Assignment Agreement;

(b) the Assignee shall indemnify and save harmless the Assignor from any action, claim or damage for which the Assignor may be held liable as a result of breaches by the Assignee of the obligations of the Lessee under the Lease Agreement arising from and after the date of this Assignment Agreement;

(c) the Assignee has the necessary corporate power and authority to enter into this Assignment Agreement; to implement the terms of this Assignment Agreement; has the power to execute and deliver the Assignment Agreement and that all necessary corporate Resolutions and other necessary documentation have been obtained to give that power and authority.

2.4 Survival and Indemnity. The representations, warranties and covenants contained in this Assignment Agreement shall survive execution hereof and remain in full force and effect for the benefit of the Assignor. The Assignee hereby covenants to indemnify and save harmless the Assignor from and against any loss, claim, action, liability, damage and cost (including costs on a solicitor and his own client basis) arising from any covenants, representations or warranties of the Assignee set forth in this Assignment Agreement being untrue, incorrect or breached.

3. GENERAL PROVISIONS

3.1 Further Assurances. Each of the parties shall execute such further documentation and perform such further acts as and when may be required to carry out and give full effect to the terms of this Assignment Agreement.

3.2 Law of Arizona. This Assignment Agreement shall be governed by and construed in accordance with the laws of the State of Arizona.

3.3 Enurement. This Assignment Agreement shall enure to the benefit of and be binding upon the parties hereto and each of their respective successors and assigns.

3.4 Counterparts. This Assignment Agreement may be signed by the parties in as many counterparts as may be necessary, each of which so signed shall be deemed to be an original, and such counterparts together shall constitute one and the same instrument and notwithstanding the date of execution shall be deemed to bear the date as set forth above.

IN WITNESS WHEREOF this Assignment Agreement has been executed as of the day and year first above written.

ETERNA-TEC CORPORATION

Per: ______________________ Pres.

____

______________________ Witness

P.D.C. INDUSTRIAL COATINGS INC.

Per: ______________________

____

______________________ Witness

LN-B3.008

ACKNOWLEDGMENT

STATE of Indiana)

County of Porter)

The foregoing instrument was acknowledged before me this 25 day of Oct, 1989, by Leroy Camel Jr,
Name
President of ETERNA-TEC CORPORATION, an Illinois
Office Held
corporation, on behalf of the corporation.

NOTARY PUBLIC

Eileen Nelson
Notary Public

My Commission expires:

2/92

LN-pl.026

ACKNOWLEDGMENT

PROVINCE OF BRITISH COLUMBIA)

DOMINION OF CANADA)

The foregoing instrument was acknowledged before me this 26th day of October, 1989, by SALIM THARANI, Director of P.D.C. INDUSTRIAL COATINGS INC., a Delaware corporation, on behalf of the corporation.

Notary Public/Being a Solicitor
Non-expiring Appointment

K. PAUL LAIL
Barrister & Solicitor
12th FLOOR-1190 HORNBY STREET
VANCOUVER, B.C.
V6Z 2L3

LN-p1.027

New Mexico and Arizona Land Company
6100 Indian School, N.E. • Suite 100 • Albuquerque, New Mexico 87110 • (505) 881-6644

June 19, 1991

Mr. Paul Arena
P. D. C. Industrial Coatings Ltd.
Suite 1708
1060 Alberni Street
Vancouver, British Columbia
V6E 4K2

Re: Mining property E1/2SE, Sec. 35, Twn 17N, Rge 19W, Mohave Co.

Dear Mr. Arena:

NEW MEXICO AND ARIZONA LAND COMPANY hereby declares that the Kaolinite Mining Lease and Agreement first dated March 1, 1984 between itself and ETERNA-TEC CORP. and subsequently assigned as requested to PDC Industrial Coatings is currently in full force and effect and was subsequently extended to include all precious metals (gold and silver) under the same terms and at the same royalty rate.

According to our records no material has been removed and sold to date. Advance royalties cumulating $40,000 have been paid.

NEW MEXICO AND ARIZONA LAND COMPANY takes no position with regard to this property beyond that of a passive lessor of fee mineral rights.

Sincerely,

J. D. Sphar
Vice President--Minerals

KAOLINITE MINING LEASE AND AGREEMENT

THIS LEASE AND AGREEMENT, made and entered into this 1st day of March, 1984, by and between NEW MEXICO AND ARIZONA LAND COMPANY, an Arizona corporation, hereinafter called "Lessor", and ETERNA-TEC CORP., an Illinois corporation, hereinafter called "Lessee".

WITNESSETH:

That the parties hereto, for the considerations hereinafter expressed, covenant and agree as follows:

1. LEASE OF PROPERTY. Lessor, upon the terms and conditions and subject to the reservations hereinafter set forth, hereby grants a lease exclusively to Lessee, for the primary term specified in Paragraph 4 hereof, to explore for, mine, remove, upgrade, process, and market Kaolinite, Montmorillonite, Zeolite, Quartz, Silica, hereinafter called only "Kaolinite", or products made from said Kaolinite and all other substances directly and necessarily associated with the taking of Kaolinite, on, under, and from the lands situated in the County of Mohave, State of Arizona, described in Exhibit "A" attached hereto and by this reference made a part hereof, said lands being hereinafter collectively referred to as the "Leased Premises", and containing one hundred acres, more or less; TOGETHER WITH all of Lessor's right of ingress and egress to and from the Leased Premises and such rights as Lessor may have to make such use of the surface of the Leased Premises as is necessary or convenient in connection with any of the foregoing activities.

2. OTHER CLAIMS. The rights and privileges granted by Lessor shall be subject, first and always, to the rights of grantees, vendees and licensees of the surface of the Leased Premises under deeds, contracts of purchase, or other agreements of record heretofore made by Lessor. Lessor shall provide Lessee with copies of all such deeds, contracts of purchase, or other agreements of record in its possession concurrent with the execution of this Lease. Lessor represents and warrants that there are no mineral leases or agreements valid and outstanding made by Lessor that would prevent the mining, recovery, development and production of Kaolinite on, under and from the Leased Premises.

It is understood that Lessee is hereby granted the right to mine only within the exterior boundaries, extended vertically downward, of the Leased Premises.

3. NEW AGREEMENTS. The right of Lessor is hereby expressly reserved to enter into new leases, permits, sales of the surface or other agreements relating to the Leased Premises not inconsistent with the rights of Lessee hereunder and that will be subordinate to and junior to Lessee's rights and operations hereunder. Provided however, that Lessor give Lessee 30 days written notice, by certified mail, that it intends to grant such lease, permit or sale.

4. TERM. The term of this Agreement shall commence on March 1st, 1984, and shall continue for twenty (20) years and as long thereafter as Lessee produces Kaolinite in paying quantities as herein provided and the other provisions of this Agreement are kept free from default. For the purposes of this

Paragraph, "paying quantities" is defined as that quantity of minerals produced which results in a royalty being paid Lessor, pursuant to Paragraph 6 and 7 hereof, of not less than Five Thousand Dollars ($5,000.00), over the period of any lease year.

5. BONUS. Lessee agrees to pay Lessor a bonus of Five Thousand Dollars ($5,000.00) in partial consideration of the rights granted hereunder. The bonus is due and payable on or before April 1, 1984, or the Agreement will terminate immediately.

6. MINIMUM ROYALTY. Lessee agrees to pay Lessor a minimum annual royalty of Five Thousand Dollars ($5,000.00) before the effective date hereof and in advance of the succeeding anniversary dates during the term hereof. In the event payment is not made herein, Lessor may terminate this Lease pursuant t Section 22 contained herein. Minimum royalty payments will be credited dollar-for-dollar against any production royalty payments due Lessor (Paragraph 7) during the lease year or succeeding years, but shall not be refunded in any event.

7. PRODUCTION ROYALTY. Lessee shall pay a production royalty to Lessor on all substances sold or removed from the Leased Premises, as follows:

In the event Lessee shall sell or remove Kaolinite, essentially in the same chemical state as it occurs naturally on the Leased Premises, and whether or not the Kaolinite is crushed and sorted, the production royalty due Lessor shall be Five Percent (5%) of the gross consideration received by Lessee for said Kaolinite, less costs of transportation to the point of sale, where applicable.

In the event Lessee shall produce other products from, or made at least in part from, the Kaolinite on the Leased Premises and shall subsequently use, remove, or sell such products, Lessee shall pay Lessor a production royalty of Five Percent (5%) of the gross consideration received by Lessee for said products, less all costs of producing said products from the raw Kaolinite beyond the point of mining and crushing and less costs of transportation, where applicable.

If Lessee shall sell Kaolinite from the Leased Premises to its parent corporation or any affiliate thereof for upgrading or benefication, Lessee shall pay to Lessor a production royalty equal to Five Percent (5%) of Lessee's or its parent's prorata entitlement to the gross consideration received by said parent or affiliate upon the sale of the upgraded or beneficiated product, less all costs to the parent or affiliate of producing same and less costs of transportation, where applicable.

If Lessor shall at any time during the term of this Lease claim that Lessee has sold Kaolinite from the Leased Premises, or other product produced from or made at least in part from said Kaolinite, to its parent corporation or any affiliate thereof at less than the fair market value of said Kaolinite or other product, then Lessor and Lessee shall meet within sixty (60) days following the making of such showing for the purpose of attempting to agree upon said fair market value. If the parties are unable to agree upon fair market value within thirty (30) days following the initial meeting, the question of fair market value shall be submitted to arbitration pursuant to Paragraph 28 hereof. Lessee shall pay to Lessor production royalty equal to Five Percent (5%) of the fair market value determined pursuant to this subparagraph, less all costs of production beyond the point of mining and crushing the raw Kaolinite and less costs of transportation, where applicable.

Lessee agrees to make full settlement of production royalties due Lessor within sixty (60) days following the end of the month with respect to which the same are due and shall submit to Lessor, with each payment, verifiable reports showing Lessee's production and sales records for said month.

If Lessor shall question the accuracy of any such report, it shall be entitled to have the same audited by a firm of independent certified public accountants to be selected by Lessor from a list of three such firms to be submitted by Lessee upon fourteen (14) days prior written notice from Lessor. The first so selected shall audit the report in question and shall submit a statement of its findings to the parties. Said statement shall be final and binding upon the parties. Any information disclosed to the firm of certified public accountants shall be confidential. If the audit statement shall conclude that there was a shortage of 5% or less in the reported royalty payment submitted by Lessee, the cost of the audit shall be paid by Lessor; if the audit statement shall conclude that there was a shortage in the reported royalty payment of more than 5% the cost of the audit shall be paid by Lessee.

8. PRUDENCE AND COMPLIANCE. Lessee agrees to enter into and upon the Leased Premises and to work and operate on the Leased Premises in the manner of a prudent operator during the period of this Agreement in accordance with accepted methods

of mining designed to discover, mine and remove Kaolinite in a good miner-like fashion. Lessee further agrees to use its best efforts to perform all work done in and upon the Leased Premises in full compliance with the mining laws and regulations of the State of Arizona.

9. INSPECTION. Lessor reserves the right through its agents or representatives to enter from time to time during ordinary business hours, into and upon all parts of the Leased Premises and workings thereon for the purpose of inspection, visual surveys, or taking samples therefrom, and Lessee agrees to render said agents or representatives proper assistance in making said inspection, visual surveys or examinations. Lessor agrees not to interfere unreasonably with Lessee's operations by virtue of such inspection and that such entry and/or inspections shall be at Lessor's sole risk.

10. INTERPRETATIVE DATA. Lessee shall provide Lessor from time to time with such technical data, excluding trade secrets or similar confidential information, as it may develop about the Leased Premises and the substances thereon. Lessor agrees that it will use its best efforts to avoid disclosure of any technical data it may obtain from Lessee. It is expressly understood that the Lessee assumes no responsibility or liability whatsoever for the use of or dependence upon, by the Lessor or any other person, any of the factual or interpretative geological or chemical data derived from or about the Leased Premises which may be furnished by the Lessee or which may otherwise come to the attention of the Lessor or any other person. The Lessee shall not be held liable by the Lessor for actions which the

Lessor may take based upon any such data supplied by the Lessee.

11. INDEMNIFICATION. Lessee shall save harmless and indemnify Lessor against all claims, demands, suits, judgments, expenses and costs of any and every kind on account of the injury to or death of persons, or loss of or damage to property arising in any manner out of or in connection with the operations of Lessee hereunder including those arising out of its failure to close effectively the surface openings of Lessee's abandoned mines. Lessee shall at Lessee's sole cost and expense defend all such claims, demands or suits subject to receipt of adequate prior notice thereof; and, if at any time Lessee employs any person or persons to work upon the Leased Premises, Lessee shall comply with the Workmen's Compensation Act of the State of Arizona and all regulations and requirements of any competent public authority. In connection with its operations hereunder, Lessee shall carry Automobile Public Liability Insurance with a limit no lower than $500,000 per occurrence property and bodily injury coverage and Comprehensive Public Liability Insurance with a limit no lower than $500,000 per occurrence property and bodily injury coverage. Upon Lessor's request, Lessee shall provide a certificate of such insurance. However, Lessor agrees that Lessee may be self-insured for all types of insurance required herein.

12. PROHIBITION AGAINST LIABILITY. Lessee shall not subject Lessor or the Leased Premises to any liability or lien for or on account of any work done or improvements made or materials placed on or used upon the Leased Premises by the Lessee, and if any such lien shall arise, Lessee shall promptly

discharge same. Notwithstanding the foregoing, Lessee may contest the validity of any such lien by appropriate judicial proceedings and during the pendency of such proceedings shall not be obligated to discharge the lien. Lessee agrees to post forthwith and keep posted on the Leased Premises in all places required by law, if any, a notice of non-liability of Lessor for operations of Lessee upon the Leased Premises.

13. TITLE. Lessor warrants to Lessee that it has such good title to the Leased Premises as it received from its grantor. Lessor agrees to indemnify and hold Lessee harmless from any adverse claim brought against Lessee based on said title consistent with the provisions contained in Section 25 herein.

14. ACCESS. Lessor has sold and conveyed the surface of the Leased Premises by various deeds, which deeds except and reserve all oil, gas and minerals underlying or appurtenant thereto together with the right of ingress and egress and of prospecting, developing and operating said lands therefor and removing the same therefrom. Lessee accepts this Agreement subject to any operating limits or restrictions imposed by such terms and provisions of said deeds. Lessor shall provide Lessee with copies of all such deeds in its possession concurrent with the execution of this Lease.

15. SURFACE OBLIGATIONS. Lessee agrees to make all payments, to the extent they may be required by law, to other surface owners for the use or damage of their lands, but no such payments for use of the surface for the purposes contemplated herein shall be required of Lessee by Lessor. Lessee will indemnify and save Lessor harmless from any and all claims of

or liability to other owners of the surface of the land occasioned by Lessee's operations hereunder.

16. ENVIRONMENTAL PROTECTION AND RESTORATION. Lessee agrees that any operations hereunder shall be conducted with as little disturbance to the surface of the Leased Premises as is consistent with the purposes hereof. Lessee agrees, at its own expense, to restore the Leased Premises to the extent consistent with good conversation management and the requirements which may be imposed by any legally constituted public authority having jurisdiction over the Leased Premises.

17. TAXES. Lessee shall file any necessary tax arising from its actions with the proper authorities. Lessee shall pay, before they become delinquent, all taxes, charges, rates and assessments which may during the term of this Agreement be levied upon or assessed with respect to the interest of the Lessee in the Leased premises, products or any personal property placed upon the Leased Premises by Lessee, together with all increases in such charges, rates or assessments upon the Leased Premises by reason of the discovery or production of Kaolinite by Lessee or on account of improvements erected upon the Leased Premises, including buildings, machinery and other fixtures placed thereon by Lessee. Notwithstanding the foregoing, Lessee may contest the amount or validity of any such tax, charge, rate or assessment, by appropriate administrative or judicial proceedings so long as the same does not result in the sale or forfeiture of all or any part of the Leased Premises or any expense to Lessor. The foregoing obligation imposed upon Lessee does not

include any obligation to pay federal or state income taxes imposed on Lessor.

18. SURRENDER OF ACREAGE. Lessee may, on any anniversary date of this Agreement, subject to the other provisions hereof, return and surrender the Leased Premises, by an appropriate instrument, in writing, duly executed and acknowledged so as to entitle the same to be recorded, and thereupon all rights and obligations of the parties hereto, one to the other, shall cease and terminate, except as to liabilities and obligations existing as of the date of such termination.

19. EXPIRATION AND SURRENDER OF LEASE. Within thirty (30) days following the expiration of this Agreement, or its earlier termination as herein provided, Lessee shall surrender the Leased Premises in good order and condition, and remove therefrom all machinery, tools and improvements that may be located thereon on the date of termination; provided, however, that following termination or expiration no such tools, machinery, or improvements shall be removed while Lessee may be in any manner indebted to Lessor under any obligation incurred under this Agreement. Lessee shall not, however, remove any improvements which may be necessary or desirable to leave in the workings to protect same from subsidence or the removal of which would make the property unduly hazardous. Lessee hereby undertakes and agrees that when any mining operations on the Leased Premises are closed down, or when this Agreement is terminated, Lessee will back-fill, fence or in some other manner effectively close or blockade all shafts, tunnels or other hazardous surface openings, and will post appropriate "No Trespassing" and caution

and danger signs at or near all such safeguards, so as to prevent persons from entering or falling into any such surface openings.

20. DELIVERY OF INFORMATION. Lessee shall furnish to Lessor within ninety (90) days following the end of each calendar year during the term hereof a brief narrative description of Lessee's operations hereunder during said calendar year, setting forth the number of tons of Kaolinite or other products produced during the year, gross receipts from all products containing Kaolinite, in whole, or in part, or processed, pertinent assays, the approximate number of acres of the Leased Premises affected by operations, the number of employees typically employed at or primarily in connection with the Leased Premises, and capital investments made during the year with respect to the Leased Premises. Upon termination of this Agreement by either party for any reason, Lessee will provide Lessor with copies of all factual geological and chemical information, excluding trade secrets or similar confidential information, which Lessee then has in its possession relating to the Leased Premises.

21. EFFECT OF TERMINATION. No termination of this Agreement whether by lapse of time or otherwise, shall release Lessee from any liability or unfulfilled obligation hereunder, whether of indemnity or otherwise, resulting from any acts, omissions, or events happening prior to the date of such termination.

22. DEFAULTS. In the event of any default by Lessee in the performance of its obligations hereunmder, where immediate termination is not a specified remedy, Lessor shall give to Lessee written notice to cure the specified default. If the

default relates to money payment and is not cured within thirty (30) consecutive days after the due date, or ten (10) consecutive days after the notice, or if the default relates to other than money payment and Lessee has not within sixty (60) days after receipt of the notice begun action to cure the same and does not thereafter diligently prosecute such action to completion, Lessor may terminate this Agreement by a second written notice to Lessee, subject to Lessee's right to remove its property and equipment from the Leased Premises, as provided above. In the event Lessee in good faith disputes the existence of a default, the parties shall arbitrate the dispute within a reasonable time and if such default is found to exist, Lessee shall have thirty (30) days after any such final determination within which to pay any disputed payment or commence correction of any default relating to other than money payments, and in such extent Lessee shall pay for all costs associated with the arbitration.

23. ADDITIONAL RENT. All costs, expenses and amounts which Lessee assumes or agrees to pay pursuant to the provisions hereof shall in the event of nonpayment, and at Lessor's election, be treated as additional rent and Lessor shall have all of the rights and remedies herein provided in the case of nonpayment of rent or breach of condition. If Lessee shall default in performing any obligation involving the expenditure of money, then Lessor shall have the right, but not the obligation, to expend the required sum for the account of Lessee (any such expenditure by Lessor to be deemed conclusive evidence of the necessity therefor) and any and all sums so expended by Lessor, with interest thereon at the rate of fifteen percent (15%) per

annum from the date of expenditure, shall be deemed to be additional rent and shall be repaid by Lessee to Lessor on demand, but no such expenditure by Lessor shall be deemed to constitute a waiver of Lessee's default nor shall the same affect any other remedy of Lessor which may arise by reason of such default.

24. ASSIGNMENTS. Neither party shall assign this Agreement or any interest therein, nor sublet any portion of the rights granted herein, except with the written consent of the other party first had and obtained in each instance, which consent shall not be unreasonably withheld, except that the parties hereto may, without the consent of the other party, assign or sublet all or any part of this Agreement or of its interest herein, to its parent corporation or any wholly owned subsidiary of its parent corporation upon written notice.

25. PROPORTIONATE REDUCTION. If Lessor owns less than the entire and undivided mineral estate in the Leased Premises insofar as the same pertains to the Kalonite subject to this Agreement, then rents and royalties shall be proportionately reduced and shall be paid to Lessor only in the proportion which Lessor's interest bears to the entire undivided estate.

In case of suit, adverse claim, dispute or question as to the ownership of the Leased Premises, or of the royalties or other payments payable under this Agreement, Lessee shall not be in default in payment of such royalties or payments until such suit, claim, dispute or question has been finally disposed of. Lessee shall have thirty (30) days after being furnished with the original instrument or instruments disposing of such suit, claim or dispute, or a certified copy thereof, or after being furnished with proof sufficient, in Lessee's opinion, to settle such question, within which to make payment. Nothing herein shall be construed to require Lessor to instigate or defend any proceedings in relation to any such dispute; provided, however, that Lessor agrees to indemnify Lessee should Lessee be determined to be liable in any manner to any such claimant or party found to have a valid ownership or royalty and to reimburse Lessee for loss of any capital improvement resulting from the diminution of the Leased Premises.

26. ARBITRATION. Any controversy or claim arising out of or relating to this Agreement, or the breach thereof, shall be settled by arbitration in accordance with the rules of the American Arbitration Association by three arbitrators. Each party shall designate one arbitrator and the two arbitrators so designated shall select the third. Judgment upon the award rendered by the arbitrators may be entered in any court having jurisdiction thereof. The exclusive place of arbitration shall be Phoenix, Arizona.

27. LITIGATION. In the event it becomes necessary for either party to file suit and obtain judgment in order to enforce or collect any arbitration award, the prevailing party in such action shall be awarded, in addition to any other amount to which it is entitled, a reasonable amount as and for its attorneys' fees and all of its costs and expenses arising out of or related to said litigation.

28. LAW APPLICABLE. This Agreement shall be governed by the laws of the State of Arizona.

29. NONWAIVER. The failure of Lessor to insist on any one or more instances upon the performance of any of the covenants and conditions herein set forth on the part of Lessee or to take action herein permitted shall not be construed as a waiver or relinquishment of the future performance of any such covenant or condition, or of Lessor's rights in regard thereto, and Lessee's obligations in such regard shall continue in full force and effect. No waiver of any default on the part of Lessee hereunder shall be deemed to arise out of or be evidenced by the acceptance of any rental or any other payment made pursuant to the provisions hereof.

30. COVENANTS OF THE LAND. The covenants, restrictions, and any other terms and conditions set forth in any deed or lease to the Leased Premises and as set forth in this Agreement are covenants running with the land both as to burden and benefit, and any conveyance made pursuant to this Agreement is subject to all said covenants, restrictions, and any other terms and conditions as though set forth in full herein.

31. INTEGRATION. This Agreement contains the entire agreement by and between the parties hereto and no oral agreement, promise, statement or representation which is not contained herein shall be binding on either party. No amendment or modification of this Agreement shall become effective unless and until the same has been reduced to writing and duly signed and acknowledged by the party against whom enforcement of any such change is sought.

32. SUCCESSORS. It is further understood that this Agreement shall be binding upon the parties hereto, their heirs, executors, administrators, successors and permitted assigns.

33. NOTICES. Any notice or communication required or contemplated by this Agreement shall be in writing and shall be given by hand delivery or by registered or certified mail addressed to the other party at its address hereinafter set forth, or at such other address as the other party hereto shall have theretofore designated in writing. Every notice or confirmation sent by mail shall be sent by registered or certified mail, return receipt requested, postage and registration or certification fee prepaid, addressed as follows in the case of Lessor:

New Mexico and Arizona Land Company
6100 Indian School Road., NE, Ste. 203
Albuquerque, NM 87110

and in the case of Lessee:

ETERNA-TEC CORP.
c/o Jann, Carroll, Sain & Dolin, Ltd.
55 East Monroe Street #4444
Chicago, Illinois 60603

and shall be deemed effective on the date mailed.

34. QUITCLAIM. Upon termination hereof, Lessee shall file for public record in the office of the appropriate County Clerk a quitclaim deed indicating release of its interest in the Leased Premises. A copy of said deed shall forthwith be provided to Lessor.

35. BROKERAGE. Each party hereto represents and warrants that all negotiations relative to this Agreement have been carried on by it directly with the other, without the intervention of any person.

36. HEADINGS. The headings of the various paragraphs of this Agreement have been inserted for convenience of reference only and shall in no way restrict or otherwise modify the terms or provisions hereof.

37. GOOD FAITH COVENANTS. The parties hereto agree to cooperate with each other throughout the term of this Agreement and/or with other parties or entities to facilitate the mutual purposes expressed hereinabove, including the execution of such additional documents as may be required.

IN WITNESS WHEREOF, the parties have caused these presents to be executed by their respective officers thereunto duly authorized as of the day and year first above written.

LESSOR:

NEW MEXICO AND ARIZONA LAND COMPANY

ATTEST:

By: ______________________
J.D. Sphar
Vice-President - Minerals

____

LESSEE:

ETERNA-TEC CORP.

ATTEST:

By: ______________________

Title: President

____

STATE OF NEW MEXICO)
)SS.
COUNTY OF BERNALILLO)

The foregoing instrument was acknowledged before me this 30 day of March, 1984, by J. D. Sphar of New Mexico and Arizona Land Company, an Arizona corporation, on behalf of said corporation.

E. M. Bedeux
Notary Public

My commission expires:

11-29-85

STATE OF ILLINOIS)
)SS.
COUNTY OF COOK)

The foregoing instrument was acknowledged before me this 26th day of March, 1984, by Lee Carnel of ETERNA-TEC CORP., an Illinois corporation, on behalf of said corporation.

Lynette McGrath
Notary Public

My commission expires:

11-4-85

EXHIBIT "A"

The east ½ of the southeast ¼ of Section 35, Township 17 North, Range 19 West, Mohave County, Arizona.

Laboratory Reports

Overview

This section contains the following reports.

- Micron Powder Systems
  This report documents that the raw Klannerite™ can be consistently reduced to various particles sizes for a particular industry.

- DL Laboratories-October 3, 1991
  This report compares Klannerite™ to PFicarb H. and Polygloss 90 as an extender or filler in paints.

- DL Laboratories-November 6, 1991
  This report documents the superior hiding efficiency (opacity) of Klannerite™.

- DL Laboratories-December 2, 1991
  This report documents the high heat reflective capabilities of our ceramic coating.

- Dl Laboratories-January 6, 1992
  Oil Absorption Test

- Cominco American-February 9, 1987
  This report shows the chemical and X-ray diffraction analysis.

- Cominco American-March 30, 1987
  This report shows an estimate of the minimum size of the deposit located at the Viva Luz Mine site.

- Rutgers University-November 15, 1991
  This report outlines the physical properties of the Klannerite™ mineral.

- Spectrochemical Laboratories Inc.
  This report shows a recent chemical analysis which verifies the earlier Cominco American chemical analysis.

LABORATORY TEST REPORT

MICRON POWDER SYSTEMS

A Member of the Hosokawa Micron Group

10 Chatham Road, Summit, New Jersey 07901

MICRON POWDER SYSTEMS
Summit, New Jersey

LABORATORY TEST REPORT

For: Heatshield Tech Inc
8400 N. University Drive
Suite 316
Tamarac, FL 33321

Attn: Mr. Paul Arena

Grinding Feasibility of Klannerite Via Air Classifying Mill

Test Date: October 2 & 3, 1991
Test No. : 91209

Date: October 28, 1991
Submitted by: P. Stadtmueller, K. Thor

Figure 1

- Equipment Utilized In Tests -

1) Model 10 ACM Air Classifying Mill
2) Vibratory Feeder
3) Stopwatch (for feed-rate calculations)
4) Cilas Granulometre

APPENDIX

Machine Type:	ACM	ACM	ACM
Run No.:	1	2	3
Mill Type:	10 ACM	10 ACM	10 ACM
Rotor Type:	4 BAR	4 BAR	4 BAR
Rotor RPM :	7000	7000	7000
Rotor AMP :	12	12	12
Sep. Type:	24 CANTED	24 CANTED	24 CANTED
Sep. RPM :	3500	3500	3500
Sep. AMP :	2	2	2
Feed Screw Type	1.75"	1.75"	1.75 "
Feed Screw RPM	--	--	--
Screen Perf.	--	--	--
Liner/Track Type	MD	MD	MD
Airflow (CFM)	300	300	300
Time:	000:26 :03	000:58 :16	003:12 :41
Rate (LB/HR):	46.0652	46.3387	39.2354
LBS. Fine :	20	45	126
LBS. Coarse :	0	0	0
Inlet Temp.(deg. F):	72.3	72.2	77.2
Feed Tube Height	--	--	--
Flow-Tron Feeder :	--	--	--
Venturi delta P:	3"	3"	3"
Mill delta P:	4"	5"	5"
Bag delta P:	0"	0"	0"
System delta P:	4"	4"	6"
Collector Type :	36-1-130	36-1-130	36-1-130
Secondary Air (CFM)	--	--	--
Elutriation Ring	--	--	--
Feed Temp (deg. F)	AMBIENT	AMBIENT	AMBIENT
Relative Humidity	--	--	--
Percent Fines :	100.00	100.00	100.00
Percent Coarse:	0.00	0.00	0.00
Mill Outlet Temp.	175 F	180 F	180 F
Feed LBS.	20.00	45	126

Run: 1

Remarks: PRE-GROUND FEED MATERIAL WAS USED IN THIS TEST.

D(97 %)=15.74 MICRONS. D(10 %)=1.26 MICRONS.

Run: 2

Remarks: THE SUPPLIED FEED WAS USED IN THIS TEST.

D(97 %)=9.53 MICRONS. D(10 %)=1.41 MICRONS.

Run: 3

Remarks: PRE-GROUND FEED WAS USED IN THIS TEST.

D(97 %)=10.86 MICRONS. D(10 %)=1.31 MICRONS.

Machine Type:	ACM	ACM
Run No.:	4	5
Mill Type:	10 ACM	10 ACM
Rotor Type:	4 BAR	4 BAR
Rotor RPM :	7000	7000
Rotor AMP :	12	12
Sep. Type:	24 CANTED	24 CANTED
Sep. RPM :	3500	3500
Sep. AMP :	2	2
Feed Screw Type	1.75 "	1.75"
Feed Screw RPM	--	--
Screen Perf.	--	--
Liner/Track Type	MD	MD
Airflow (CFM)	300	300
Time:	003:03 :11	003:15 :15
Rate (LB/HR):	43.5629	34.7247
LBS. Fine :	133	113
LBS. Coarse :	0	0
Inlet Temp.(deg. F):	73.7	77.2
Feed Tube Height	--	--
Flow-Tron Feeder :	--	--
Venturi delta P:	3"	3"
Mill delta P:	4"	3"
Bag delta P:	0"	0"
System delta P:	6"	5"
Collector Type :	36-1-130	36-1-130
Secondary Air (CFM)	--	--
Elutriation Ring	--	--
Feed Temp (deg. F)	AMBIENT	AMBIENT
Relative Humidity	--	--
Percent Fines :	100.00	100.00
Percent Coarse:	0.00	0.00
Mill Outlet Temp.	180 F	180
Feed LBS.	133	113

Run: 4

Remarks: THE SUPPLIED FEED WAS USED IN THIS TEST.

D(97 %)=13.12 MICRONS. D(10 %)=1.42 MICRONS.

Run: 5

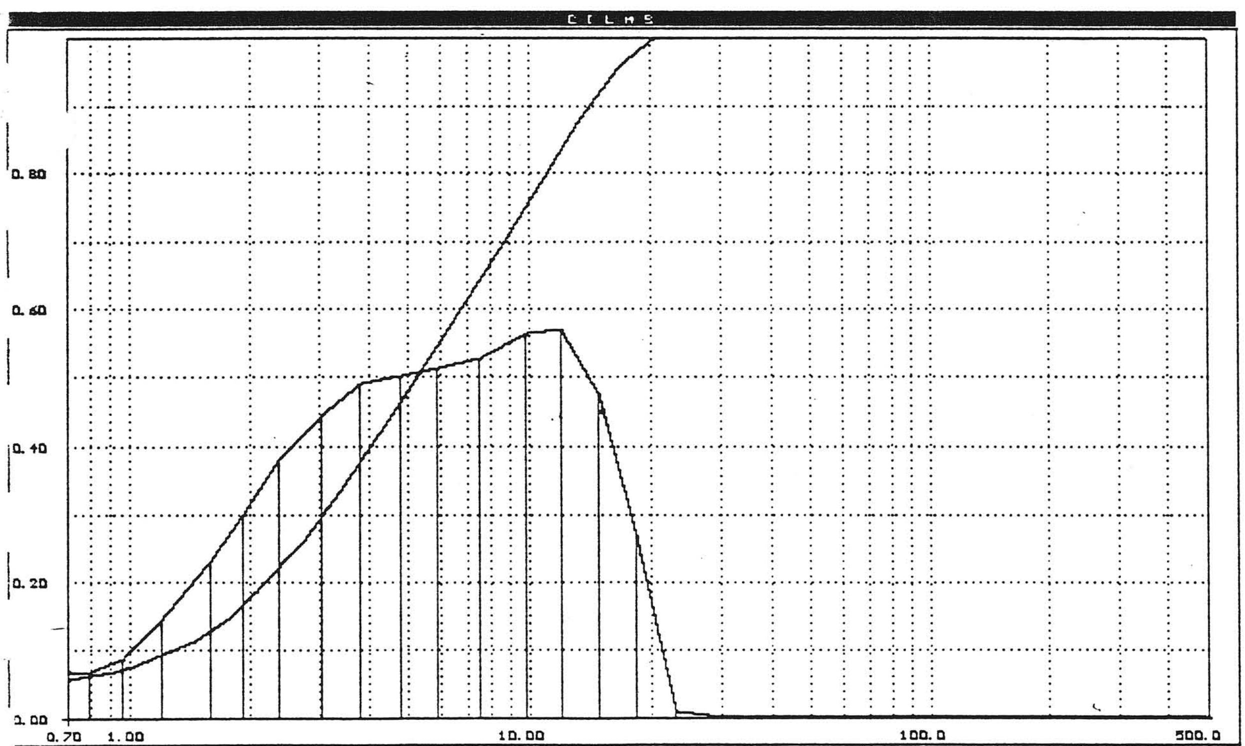
Remarks: SUPPLIED FEED WAS USED IN THE TEST.

D(97 %)=10.86 MICRONS. D(10 %)=1.24 MICRONS.

------------------- Granulometer CILAS 920 number 0075 -------------------

Sample	: TEST 1				
Liquid	: WATER				
Ultrasonic mixer	: 120 s. / Dispersing agent : TX100				
Comment	:				
User name	:				
Date/time	: 10/02/1991 12:45:10				
Plant	:				
Place	:				
Concentration	: 29		Total weight	:	975.23
			Total surf. area	:	200.56
Median size	: 4.91 mu		Mean size	:	6.09 mu
Diameter at 10.0 %	: 1.26 mu		Stnd deviation	:	4.38 mu
Diameter at 97.0 %	: 15.74 mu				

D	0.7	0.9	1.0	1.4	1.7	2.0	2.6	3.2	4.0	5.0
T%	5.4	6.7	7.4	11.2	14.7	18.5	26.3	33.5	42.0	50.7
D	6.0	8.0	10.0	12.0	15.0	18.0	23.0	30.0	36.0	45.0
T%	58.0	69.8	79.6	87.7	96.0	99.8	100.0	100.0	100.0	100.0
D	56.0	70.0	90.0	110.0	135.0	165.0	210.0	260.0	320.0	400.0
T%	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0



C:\GRAN\$$$$$001.MES H * 5

------------------- Granulometer CILAS 920 number 0075 -------------------

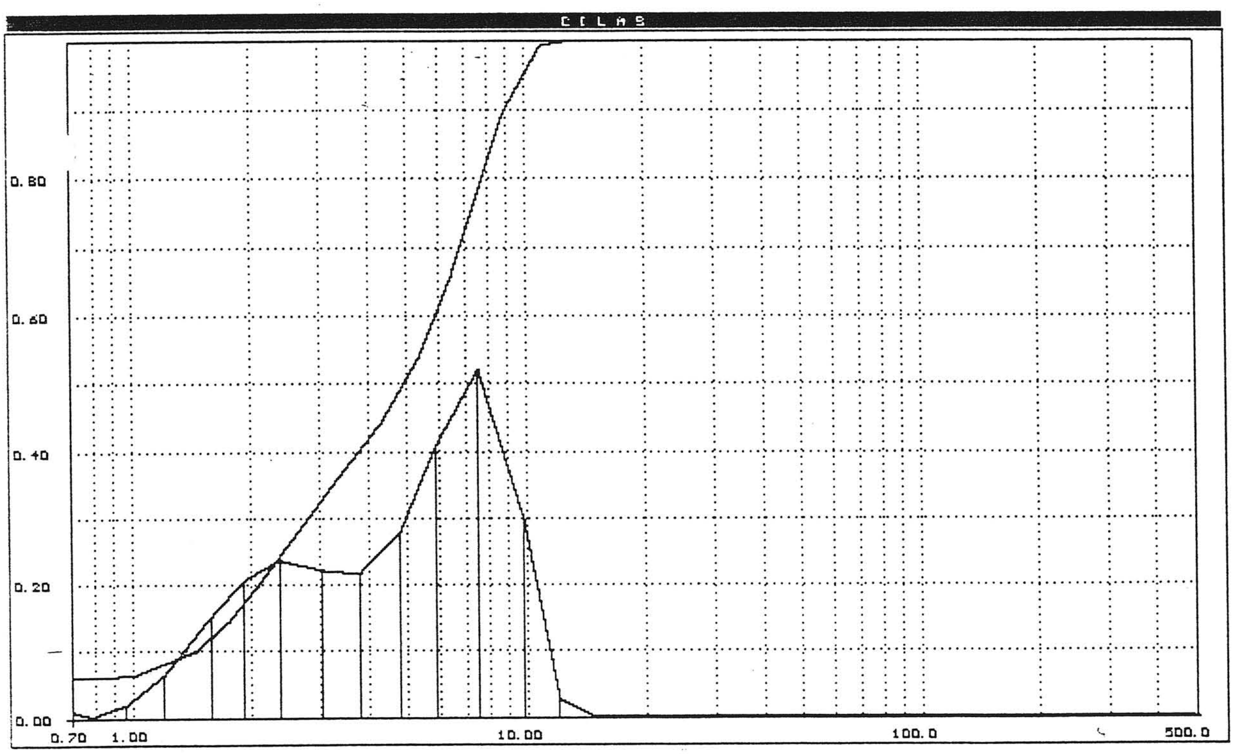
Sample : TEST 2

Liquid : WATER
U :rasonic mixer : 120 s. / Dispersing agent : TX100
Comment :
User name : BILL
Date/time : 10/02/1991 11:00:23
Plant : HEATSHIELD
Place :
Concentration : 5

Total weight : 175.37
Total surf. area : 38.59
Mean size : 4.68 mu
Stnd deviation : 2.61 mu

Median size : 4.58 mu
Diameter at 10.0 % : 1.41 mu
Diameter at 97.0 % : 9.53 mu

D	0.7	0.9	1.0	1.4	1.7	2.0	2.6	3.2	4.0	5.0
T%	6.1	6.1	6.4	9.8	14.4	19.6	29.3	36.5	44.1	53.8
D	6.0	8.0	10.0	12.0	15.0	18.0	23.0	30.0	36.0	45.0
T%	65.5	88.9	99.2	100.0	100.0	100.0	100.0	100.0	100.0	100.0
D	56.0	70.0	90.0	110.0	135.0	165.0	210.0	260.0	320.0	400.0
T%	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0



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------------------- Granulometer CILAS 920 number 0075 -------------------

Sample : TEST 3

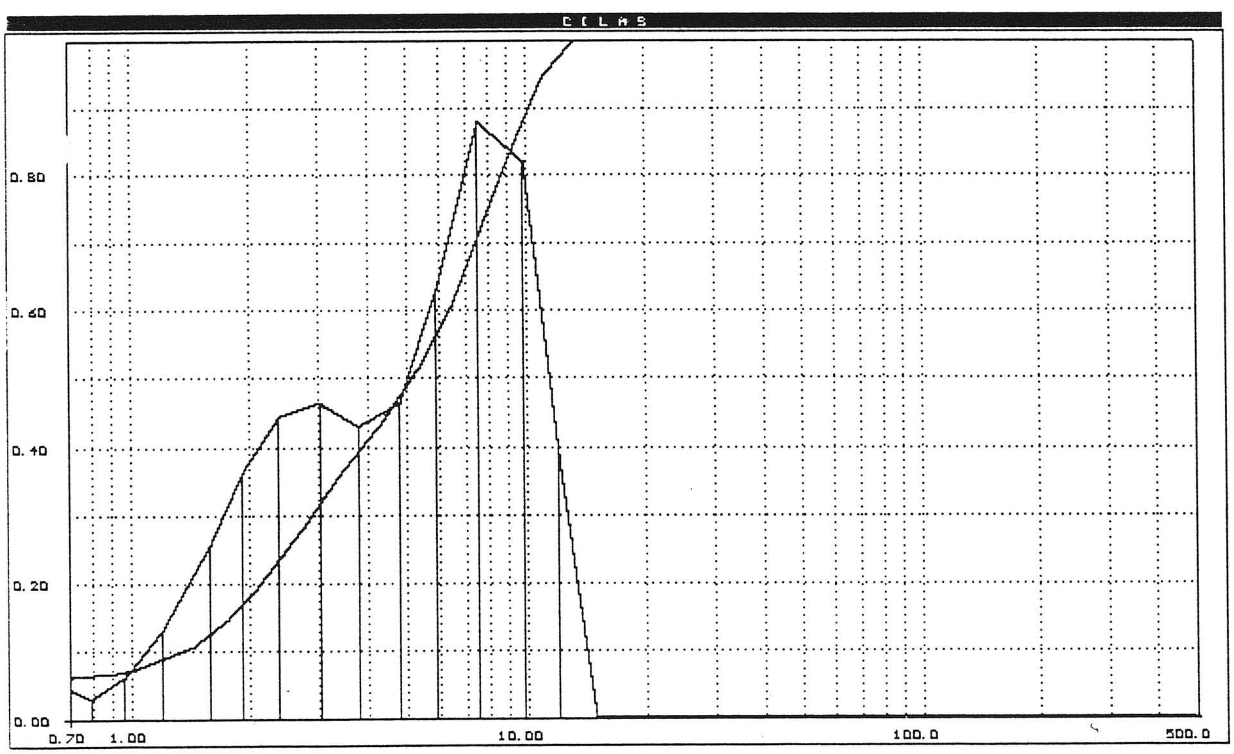
Liquid : WATER
Ultrasonic mixer : 45 s. / Dispersing agent : TX100
Comment :
User name : THOR/STADTMUELLER
Date/time : 10/02/1991 14:05:24
Plant : HEATSHIELD
Place :
Concentration : 6

Total weight : 175.81
Total surf. area : 38.33

Median size : 4.81 mu
Diameter at 10.0 % : 1.31 mu
Diameter at 97.0 % : 10.86 mu

Mean size : 5.06 mu
Stnd deviation : 3.01 mu

D	0.7	0.9	1.0	1.4	1.7	2.0	2.6	3.2	4.0	5.0
T%	6.1	6.7	7.2	10.7	14.6	19.2	28.3	35.8	43.3	51.4
D	6.0	8.0	10.0	12.0	15.0	18.0	23.0	30.0	36.0	45.0
T%	60.4	80.2	94.5	100.0	100.0	100.0	100.0	100.0	100.0	100.0
D	56.0	70.0	90.0	110.0	135.0	165.0	210.0	260.0	320.0	400.0
T%	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0



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------------------- Granulometer CILAS 920 number 0075 -------------------

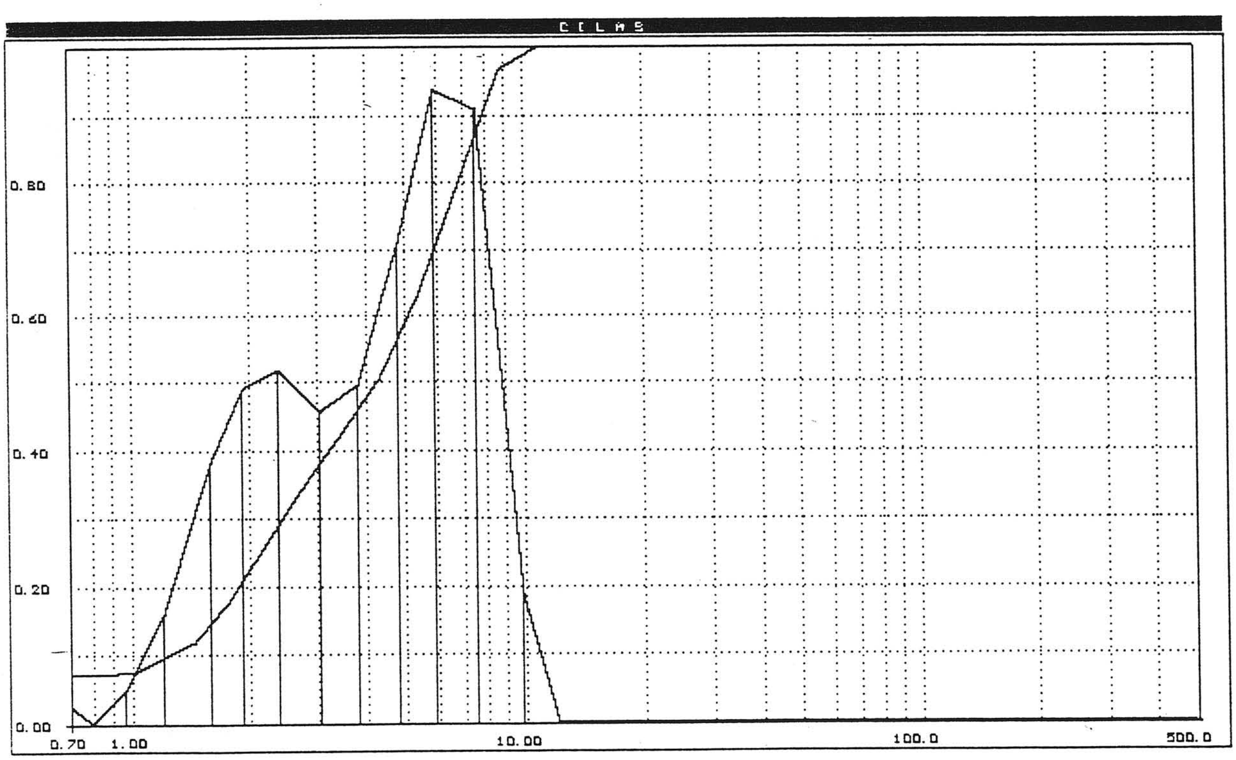
Sample : TEST THREE, 2 HR.

Liquid : WATER
Ultrasonic mixer : 45 s. / Dispersing agent : TX100
Comment :
User name : THOR,STADTMUELLER
Date/time : 10/02/1991 15:18:34
Plant : HEATSHIELD
Place :
Concentration : 7

Total weight : 217.62
Total surf. area : 53.99
Mean size : 4.09 mu
Stnd deviation : 2.30 mu

Median size : 3.96 mu
Diameter at 10.0 % : 1.21 mu
Diameter at 97.0 % : 8.16 mu

D	0.7	0.9	1.0	1.4	1.7	2.0	2.6	3.2	4.0	5.0
T%	7.2	7.2	7.6	11.8	17.6	23.8	34.4	41.8	50.4	62.8
D	6.0	8.0	10.0	12.0	15.0	18.0	23.0	30.0	36.0	45.0
T%	76.2	96.7	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
D	56.0	70.0	90.0	110.0	135.0	165.0	210.0	260.0	320.0	400.0
T%	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0



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------------------- Granulometer CILAS 920 number 0075 -------------------

Sample : TEST THREE, 3 HR.

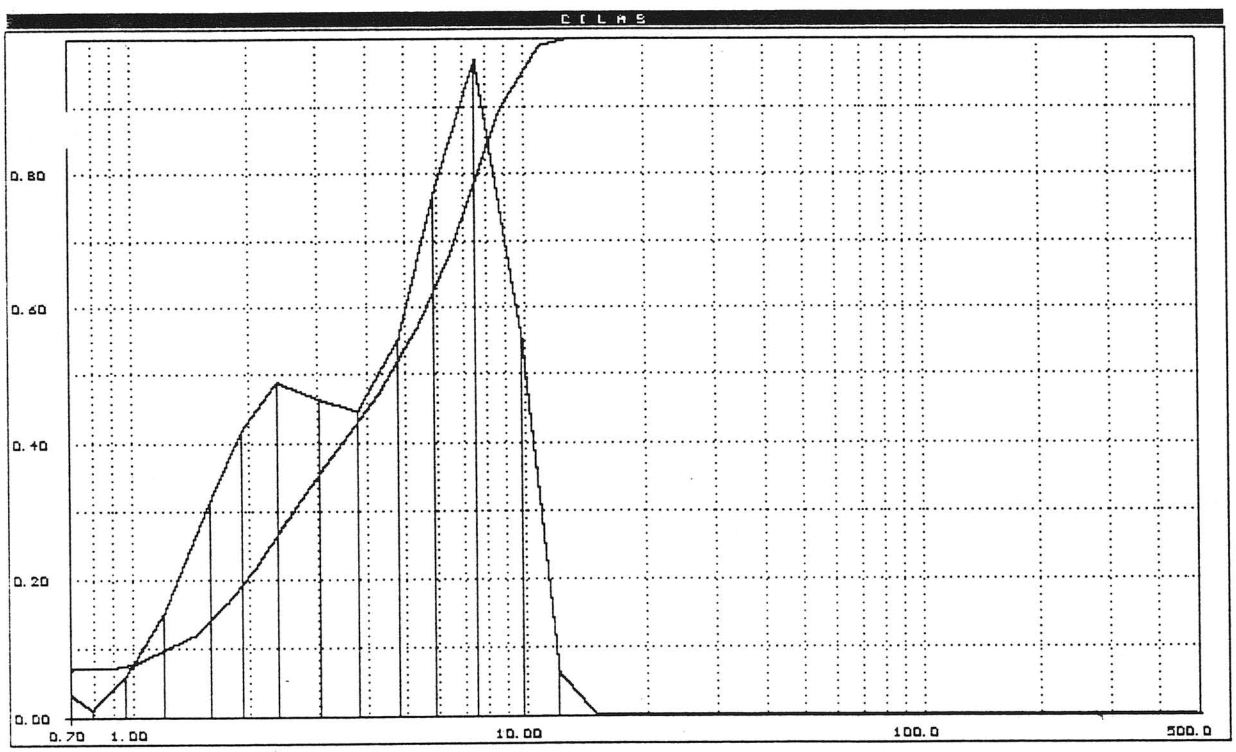
Liquid : WATER
Ultrasonic mixer : 120 s. / Dispersing agent : TX100
Comment :
User name : THOR,STADTMUELLER
Date/time : 10/02/1991 16:29:43
Plant : HEATSHIELD
Place :
Concentration : 16

Total weight : 454.83
Total surf. area : 108.18

Median size : 4.28 mu
Diameter at 10.0 % : 1.21 mu
Diameter at 97.0 % : 9.52 mu

Mean size : 4.52 mu
Stnd deviation : 2.64 mu

D	0.7	0.9	1.0	1.4	1.7	2.0	2.6	3.2	4.0	5.0
T%	7.0	7.2	7.7	11.7	16.5	21.8	31.8	39.3	47.1	56.7
D	6.0	8.0	10.0	12.0	15.0	18.0	23.0	30.0	36.0	45.0
T%	67.7	89.5	99.1	100.0	100.0	100.0	100.0	100.0	100.0	100.0
D	56.0	70.0	90.0	110.0	135.0	165.0	210.0	260.0	320.0	400.0
T%	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0



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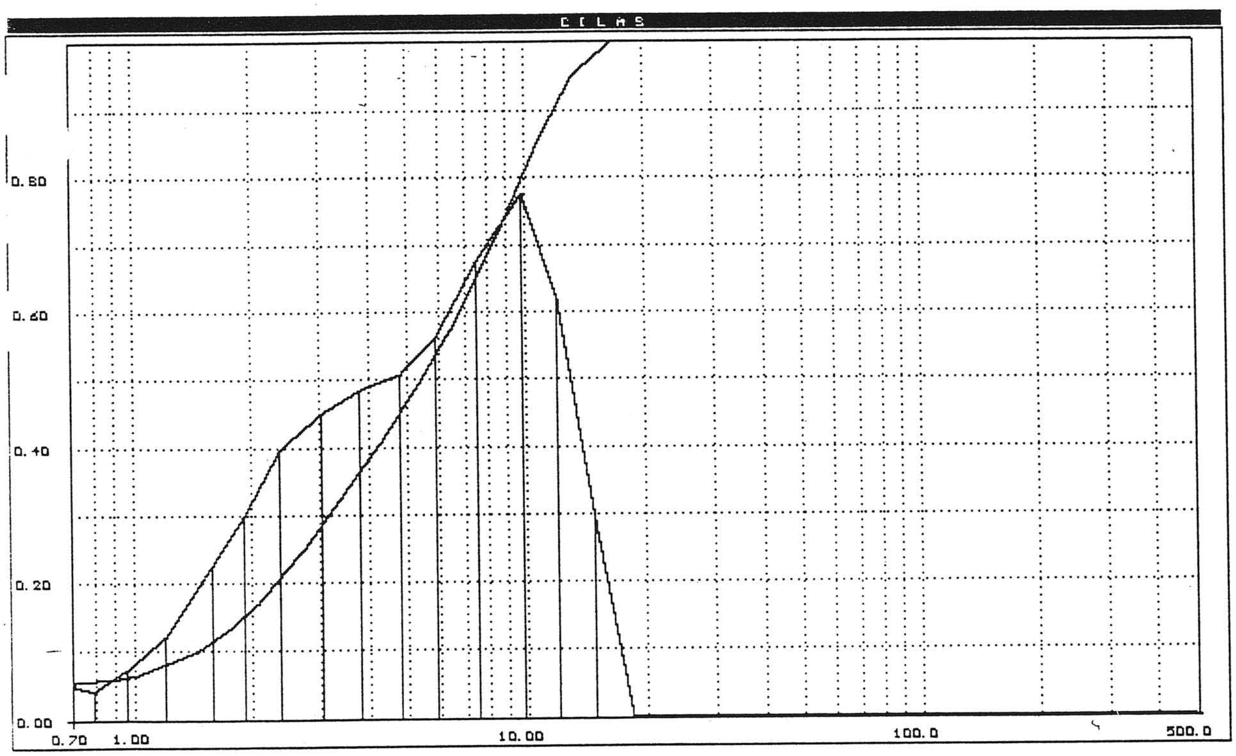
------------------- Granulometer CILAS 920 number 0075 ------------------

Sample	: TEST 4				
Liquid	: WATER				
Ultrasonic mixer	: 120 s. / Dispersing agent : TX100				
Comment	:				
User name	: THOR/STADTMUELLER				
Date/time	: 10/04/1991 08:13:15				
Plant	: HEATSHIELD				
Place	:				
Concentration	: 7	Total weight	:	252.08	
		Total surf. area	:	50.09	
Median size	: 5.06 mu	Mean size	:	5.66	mu
Diameter at 10.0 %	: 1.42 mu	Stnd deviation	:	3.57	mu
Diameter at 97.0 %	: 13.12 mu				

D	0.7	0.9	1.0	1.4	1.7	2.0	2.6	3.2	4.0	5.0
T%	5.1	5.9	6.5	9.7	13.1	16.9	25.0	32.3	40.7	49.5

D	6.0	8.0	10.0	12.0	15.0	18.0	23.0	30.0	36.0	45.0
T%	57.5	72.7	86.2	95.0	100.0	100.0	100.0	100.0	100.0	100.0

D	56.0	70.0	90.0	110.0	135.0	165.0	210.0	260.0	320.0	400.0
T%	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0



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------------------- Granulometer CILAS 920 number 0075 -------------------

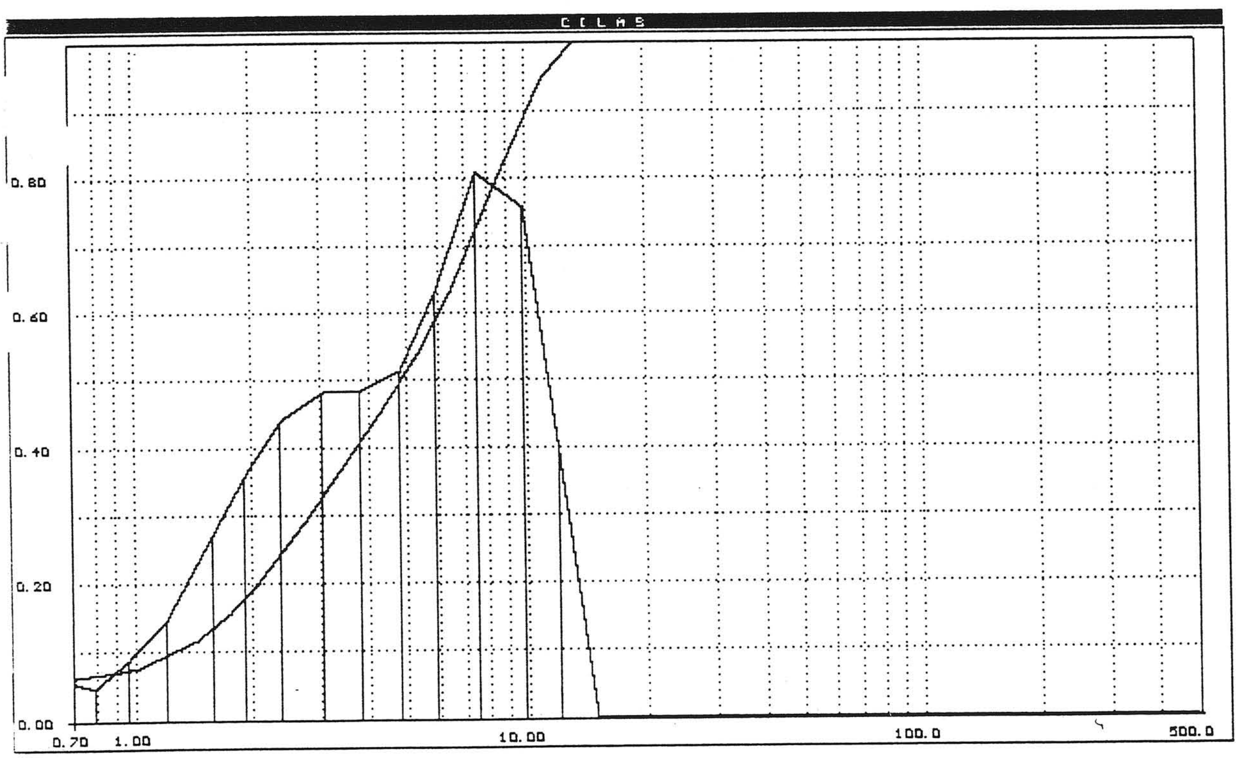
Sample : TEST 5

Liquid : WATER
Ultrasonic mixer : 90 s. / Dispersing agent : TX100
Comment :
User name : THOR/STADTMUELLER
Date/time : 10/03/1991 15:47:44
Plant : HEATSHIELD
Place :
Concentration : 13

Total weight : 395.13
Total surf. area : 87.65
Mean size : 4.93 mu
Stnd deviation : 3.00 mu

Median size : 4.51 mu
Diameter at 10.0 % : 1.24 mu
Diameter at 97.0 % : 10.86 mu

D	0.7	0.9	1.0	1.4	1.7	2.0	2.6	3.2	4.0	5.0
T%	6.0	6.9	7.6	11.4	15.5	20.0	29.0	36.8	45.2	54.1
D	6.0	8.0	10.0	12.0	15.0	18.0	23.0	30.0	36.0	45.0
T%	63.1	81.3	94.5	100.0	100.0	100.0	100.0	100.0	100.0	100.0
D	56.0	70.0	90.0	110.0	135.0	165.0	210.0	260.0	320.0	400.0
T%	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0



C:\GRAN\$$$$$006.MES

H * 5

LABORATORIES
116 East 16th Street
New York, New York 10003
212·777·4410
212·505·8419 FAX

October 3, 1991

Mr. Paul Arena
President
HeatShield Technologies, Inc.
10580 N.W. 41st Street
Coral Springs, FL 33065

Dear Paul:

Enclosed is our report on the results of our study on the effectiveness of KLANNERITE in latex and alkyd coatings. As you will note, and as discussed, KLANNERITE does have some potential for use in coatings. Other performance properties in additional coating formulations should be studied and additional control products should be included. Of course, the selling price of KLANNERITE will also be of prime consideration when determining its potential.

We look forward to your comments after you have reviewed this report.

Sincerely,

Saul Spindel

Saul Spindel
President

jb
cc: F. Holtzman
T. Sliva

LABORATORIES

116 East 16th Street, New York, N.Y. 10003
Telephone: 212-777-4410
TWX: 710-581-6132

(ESTABLISHED 1932)

DL-8658

EVALUATION OF KLANNERITE VS PFICARB H & POLYGLOSS 90 IN TYPICAL LATEX AND ALKYD ENAMELS

HeatShield Technologies, Inc.
October 1, 1991

D/L Laboratories

Saul Spindel
President

CW

OBJECTIVE

To compare two particle size distributions of KLANNERITE vs PfiCarb H in a typical white semi-gloss latex enamel and vs Polygloss 90 in a typical white alkyd enamel.

PRODUCTS TESTED

KLANNERITE

T3 - Test 3 - 1.5 to 25 microns

T6 - Test 6 - 1 to 5 microns

Controls

Latex - PfiCarb H (Precipitated calcium carbonate) Pfizer Inc. (18¢/lb) *

Alkyd - Polygloss 90 (Proprietary clay) J. M. Huber Corp.. (16¢/lb) *

* - Selling Price

FORMULATIONS

The formulations prepared and tested are shown in Appendix I. Substitutions were made at equal weight.

Appendix IA - White Semi-Gloss Latex Enamel

Appendix IB - White Alkyd Enamel

TEST DATA

The test results are shown in Appendix II

Appendix IIA - White Semi-Gloss Latex Enamel

Appendix IIB - White Alkyd Enamel

Appendix III - Viscosity Profile

TEST DATA (cont)

Inasmuch as some of the tests were subjective, the observations made have been scored using the following ASTM Standardized Scoring System in Order to avoid lengthy descriptions:

Score	Performance	or	Effect
10	Perfect		None
9	Excellent		Trace
8	Very good		Very slight
6	Good		Slight
4	Fair		Moderate
2	Poor		Considerable
1	Very poor		Severe
0	No value		Complete failure

TEST PROCEDURES

The following test procedures were employed in this study:

Test	Method
Ease of Dispersion	Rate - ASTM Scoring System
Fineness of Grind	ASTM D-1240
Viscosity	ASTM D-562
Freeze-Thaw (5 cycles)	ASTM D-2243
Package Stability	ASTM D-1849
Opacity	FTMS 6122
Brightness	ASTM E-97
Gloss	ASTM D-523
Adhesion	ASTM D-3359
Hardness	ASTM D-3363
Flexibility	ASTM D-522
Direct Impact	ASTM D-2794

TEST PROCEDURES (cont)

Test	Method
Abrasion	ASTM D-4060
Washability	ASTM D-3450
Scrub Resistance	ASTM D-2486
Application	Rate - ASTM Scoring Scheme
Chemical Resistance	ASTM D-1308
Moisture Vapor Permeability	ASTM D-1653
Salt Spray	ASTM B-117
Humidity	ASTM D-4585
Accelerated Weathering	ASTM G-53
Thermal Reflectivity	Infra-red bulb 12" from panel. Measure temperature.
Viscosity Profile	Bohlin Viscometer

ANALYSIS OF RESULTS

The test results may be analyzed most readily by rating the performance of the KLANNERITE pigments vs the control used in each type of enamel tested. These ratings are shown in the tables below using the following rating scheme.

++ = Decidedly superior vs the Control

+ = Significantly superior vs the Control

= = Equivalent to the Control

- = Significantly inferior vs the Control

-- = Decidedly inferior vs the Control

Table 1 - Vs PfiCarb H in the White Semi-Gloss Latex Enamel

Table 2 - Vs Polygloss 90 in the White Alkyd Enamel

TABLE 1

White Semi-Gloss Latex Enamel
(Vs PfiCarb H)

		KLANNERITE T-6 (1 - 5u)	KLANNERITE T-3 (1.5 - 25u)
Ease of Dispersion		=	=
Fineness of Grind		=	-
Viscosity		=	=
Stability		-	=
Freeze-thaw		=	=
Package Stability		=	=
Opacity		+	=
Brightness		-	=
Gloss - 60°		+	=
Sheen - 85°		+	-
Adhesion		=	=
Hardness		=	=
Flexibility		=	=
Impact		=	=
Abrasion Resistance		=	-
Washability		=	-
Scrub Resistance		-	-
Application			
Brush		=	=
Roller		=	=
Chemical Resistance			
Water		++	+
Alkali		=	=
Acid		=	=
MV Permeability		=	=
Salt Fog Resistance		=	=
Humidity Resistance		++	++
Accelerated Weathering		=	=
Thermal Reflectivity		=	=
Viscosity Profile		=	=
Tentative TOTAL	+	7	3
	-	3	5
" NET		+4	-2

TABLE 2

Gloss White Alkyd Enamel
(Vs Polygloss 90)

		KLANNERITE T-6 (1 – 5u)	KLANNERITE T-3 (1.5 – 25u)
Ease of Dispersion		=	=
Fineness of Grind		=	–
Viscosity		=	=
Stability		–	=
Package Stability		=	–
Opacity		+	=
Brightness		–	=
Gloss		=	–
Adhesion		=	=
Hardness		=	=
Flexibility		=	=
Impact		–	–
Abrasion Resistance		=	=
Washability		=	=
Scrub Resistance		=	+
Application			
Brush		=	+
Roller		=	–
Chemical Resistance			
Water		=	=
Alkali		=	=
Acid		=	+
MV Permeability		=	=
Salt Fog Resistance		=	=
Humidity Resistance		=	=
Accelerated Weathering		=	=
Thermal Reflectivity		=	=
Viscosity Profile		=	=
Tentative TOTAL	+	1	3
	–	3	5
" NET		-2	-2

CONCLUSIONS

1. KLANNERITE T-6 (1-5u) exhibits the following significant differences in properties when compared with PfiCarb H in a white semi-gloss latex enamel:

Decidedly superior	-	Water resistance Humidity resistance
Significantly superior	-	Opacity Gloss Sheen
Significantly inferior	-	Viscosity stability Brightness Scrub resistance
Decidedly inferior	-	None

All other properties are essentially equal.

2. KLANNERITE T-3 (1.5-25u) exhibits the following significant differences in properties when compared with PfiCarb H in a white semi-gloss latex enamel:

Decidedly superior	-	Humidity resistance
Significantly superior	-	Water resistance
Significantly inferior	-	Fineness of grind Sheen Brightness Abrasion resistance Washability Scrub resistance
Decidedly inferior	-	None

CONCLUSIONS (cont)

3. KLANNERITE T-6 (1-5u) exhibits the following significant differences in properties when compared with Polygloss 90 in a gloss white alkyd enamel:

Decidedly superior	-	None
Significantly superior	-	Opacity
Significantly inferior	-	Viscosity stability Brightness Impact resistance
Decidedly inferior	-	None

All other properties are essentially equal.

4. KLANNERITE T-3 (1.5-25u) exhibits the following significant differences in properties when compared with Polygloss 90 in a gloss white alkyd enamel.

Decidedly superior	-	None
Significantly superior	-	Scrub resistance Brush application Acid resistance
Significantly inferior	-	Fineness of grind Package stability Gloss Brightness Impact resistance
Decidedly inferior	-	None

5. Overall, the KLANNERITE pigments tend to be:

Superior in Water resistance and Humidity resistance

but

Inferior in Brightness.

CONCLUSIONS (cont)

6. KLANNERITE T-6, the 1-5u grade, tends to increase Opacity but at a sacrifice in Viscosity Stability and Brightness.

   One the other hand, KLANNERITE T-3, the 1.5-25u grade, exhibits inferior Fineness of Grind, Brightness and Abrasion Resistance with no significant advantages, overall.

RECOMMENDATIONS

1. KLANNERITE T-6 exhibits potential for use in the coatings industry. In both of the formulations studied, KLANNERITE T-6 resulted in coatings that exhibited superior opacity vs the control formulations. This advantage may be attributable to the reduced brightness of the KLANNERITE product or it may be attributable to a TiO_2 spacing capability i.e. enhanced hiding potential, of KLANNERITE T-6. This potential should be evaluated.

2. KLANNERITE T-3 is not sufficiently fine in particle size distribution to be used in gloss and semi-gloss paints. It is, however, probably adequate for use in flat paint formulations.

3. The superior water and humidity resistance exhibited by the KLANNERITE coatings suggest the product may also have potential use in chemical resistance, maintenance type coatings.

APPENDIX IA

FORMULATIONS

WHITE SEMI-GLOSS LATEX

		PfiCarb	KLANNERITE	
L ------------->		H	T-6	T-3
	(%)			
Propylene Glycol		60.0	------------------------------>	
Foamaster VL		1.0	------------------------------>	
Tamol SG-1		7.0	------------------------------>	
Water		70.0	------------------------------>	
TiPure R-900		100.0	------------------------------>	
Pficarb H		105.0	--	--
KLANNERITE T-6		--	105.0	--
KLANNERITE T-3		--	--	105.0
		Disperse on a high speed disperser		
Water		175.0	------------------------------>	
Rhoplex AC-64	(60.5)	316.7	------------------------------>	
Texanol		9.5	------------------------------>	
Nuosept 95		1.0	------------------------------>	
Foamaster VL		3.0	------------------------------>	
Water		29.7	------------------------------>	
		Adjust pH to 10.0		
Ammonium Hydroxide	(28.0)	3.2	5.0	7.0
Acrysol RM-5 }	(30.0)	55.0	------------------------------>	
Water } Premix		50.0	------------------------------>	
		Adjust pH to 8.4 ± 0.2		
Water		6.2	4.5	5.7
Ammonium Hydroxide	(28.0)	3.3	3.5	--
TOTAL WEIGHT	Lbs	995.6	995.9	995.6
TOTAL YIELD	Gals	99.9	100.1	100.1

APPENDIX IB

FORMULATIONS

WHITE ALKYD ENAMEL

A ----------->	(%)	Polygloss H	KLANNERITE T-6	KLANNERITE T-3
Cargill 5070	(70)	236.0	----------------->	----------------->
Nuosperse 657		3.0	----------------->	----------------->
TiPure R-960		210.0	----------------->	----------------->
Polygloss 90		175.0	----------------->	----------------->
KLANNERITE T-6			175.0	
KLANNERITE T-3				175.0
		Disperse on a high speed disperser		
Mineral Spirits		130.0	----------------->	----------------->
Cargill 5070	(70)	244.0	----------------->	----------------->
Cobalt Nuxtra	(6)	1.7	----------------->	----------------->
Zirconium Nuxtra	(6)	5.6	----------------->	----------------->
Calcium Nuxtra	(4)	1.9	----------------->	----------------->
Exkin 2		1.0	----------------->	----------------->
TOTAL WEIGHT	Lbs	1008.2	----------------->	----------------->
TOTAL YIELD	Gals	96.7	----------------->	----------------->

APPENDIX IIA

TEST RESULTS

Interior White Semi-Gloss Latex

		PfiCcarb H	KLANNERITE T-6	KLANNERITE T-3
Ease of Dispersion	Score	10	10	10
Fineness of Grind	Hegman	5.5	5.5	4.5
Viscosity				
Initial	KU	88	99	91
2 weeks at 125°F	"	93	118	96
Maximum change	"	5	19	5
Freeze Thaw	KU	93	110	93
Change	"	5	11	2
Package Stability - 2 weeks at 125°F				
Skinning	Score	10	10	10
Phase Separation	"	10	10	10
Settling	"	10	10	10
Caking	"	10	10	10
Ease of Remix	"	10	10	10
Seeding	"	10	10	10
Freeze Thaw	5 cycles	Pass	Pass	Pass
Opacity	%	91.9	94.6	92.2
Brightness (Reflectance	%	89.0	85.3	88.4
Gloss 60°	Units	6	15	8
Sheen - 85°	Units	44	70	8
Adhesion	Rating a	3B	3B	3B
	% b	82	82	82
Hardness	Pencil	HB	HB	HB

a - ASTM D-3359, Method A
b - ASTM D-3359, Method B

APPENDIX IIA (cont)

TEST RESULTS

Interior White Semi-Gloss Latex

		PfiCcarb	KLANNERITE	
		H	T-6	T-3
Flexibility				
1/8 inch rod		Pass	Pass	Pass
Direct Impact	Inch Lbs	160	160	160
Abrasion Resistance	Mgs Loss	40.6	41.2	50.0
Washability				
Reflectance recovery	%	98.8	99.3	94.9
Scrub Resistance	Cycles	455	270	325
Application				
Brush				
Leveling	Score	4	4	4
Sag	"	10	10	10
Roller				
Leveling	Score	10	8	10
Sag	"	10	10	10
Appearance	"	10	10	10
Chemical Resistance				
Water				
Time to failure	Hours	<1	336	72
Blistering	ASTM	0	8F	8D
NaOH - 10%				
Time to failure	Hours	<1	<1	<1
Lifting	Score	0	0	0
HCl - 10%				
Time to failure	Hours	<1	<1	<1
Lifting	Score	0	0	0
Moisture Vapor Permeability		5.53	5.30	5.34

APPENDIX IIA (cont)

TEST RESULTS

Interior White Semi-Gloss Latex

		PfiCcarb	KLANNERITE	
		H	T-6	T-3
Salt Spray (Fog) Resistance - 300 hours				
Time to failure	Hours	100	100	100
Blistering	ASTM	8D	6M	6M
Humidity Resistance - 300 hours				
Time to failure	Hours	24	300	300
Blistering	ASTM	0	10	10
Accelerated Weathering - 300 hours				
Color change	Score	10	10	10
Gloss change	"	10	10	10
Chalking	"	10	10	10
Thermal Reflectivity - Infra Red				
Temperature				
Initial	°F	78	76	76
After 5 minutes		126	125	130
10 "		130	133	135
15 "		132	136	135
20 "		134	138	135
25 "		134	141	135
30 "		134	141	135

APPENDIX IIB

TEST RESULTS

White Alkyd Enamel

		Polygloss 90	KLANNERITE T-6	KLANNERITE T-3
Ease of Dispersion	Score	10	10	10
Fineness of Grind	Hegman	6	6	4
Viscosity				
Initial	KU	97	96	96
2 weeks at 125°F	"	106	111	103
Maximum change	"	9	15	7
Package Stability - 2 weeks at 125°F				
Skinning	Score	6	6	6
Phase Separation	"	9	9	9
Settling	"	10	10	6
Caking	"	10	10	6
Ease of Remix	"	10	10	4
Seeding	"	10	10	10
Opacity	%	97.6	98.3	97.4
Brightness (Reflectance)	%	88.5	84.8	86.6
Gloss				
60°	Units	91	92	79
20°	"	75	76	32
Adhesion	Rating a	3B	3B	4B
	% b	82	82	91
Hardness	Pencil	2B	2B	2B
Flexibility				
1/8 inch rod		Pass	Pass	Pass
Direct Impact	Inch Lbs	138	100	110
Abrasion Resistance	Mgs Loss	42.0	47.8	48.2

a - ASTM D-3359, Method A
b - ASTM D-3359, Method B

APPENDIX IIB (cont)

TEST RESULTS

White Alkyd Enamel

		Polygloss 90	KLANNERITE T-6	KLANNERITE T-3
Washability				
Reflectance recovery	%	98.8	99.3	99.3
Scrub Resistance	Cycles	640	610	1090
Application				
Brush				
Leveling	Score	4	4	9
Sag	"	10	9	10
Spray				
Leveling	Score	10	10	10
Sag	"	9	8	2
Chemical Resistance				
Water				
Time to failure	Hours	48	48	48
Blistering	ASTM	6D	8D	8D
NaOH - 10%				
Time to failure	Hours	1	1	1
Lifting	Score	0	0	0
HCl - 10%				
Time to failure	Hours	24	24	24
Lifting	Score	0	0	6
Moisture Vapor Permeability	Perms	1.71	1.62	1.76
Salt Spray (Fog) Resistance - 300 hours				
Time to failure	Hours	300	300	300
Blistering	ASTM	8F	8M	8M
Rusting	Score	7	7	5
Humidity Resistance - 300 hours				
Time to failure	Hours	250	250	250
Blistering	ASTM	6D	8D	8D
Rusting	ASTM	10	10	10

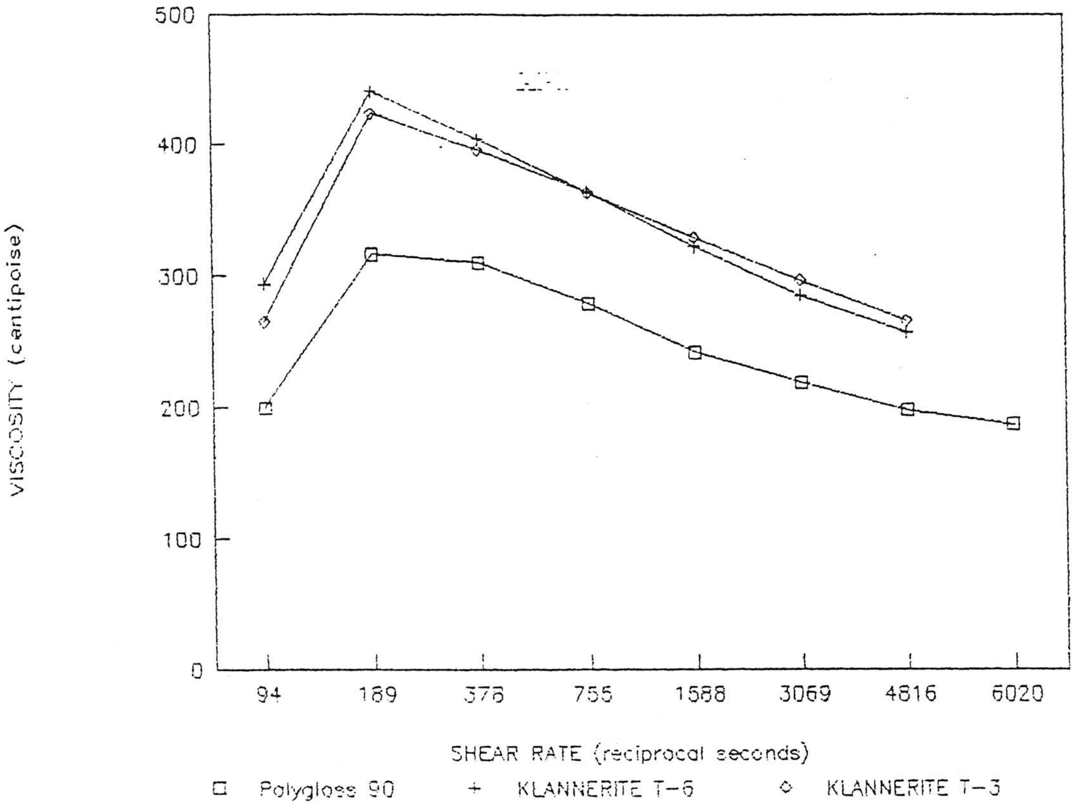
APPENDIX IIB (cont)

TEST RESULTS

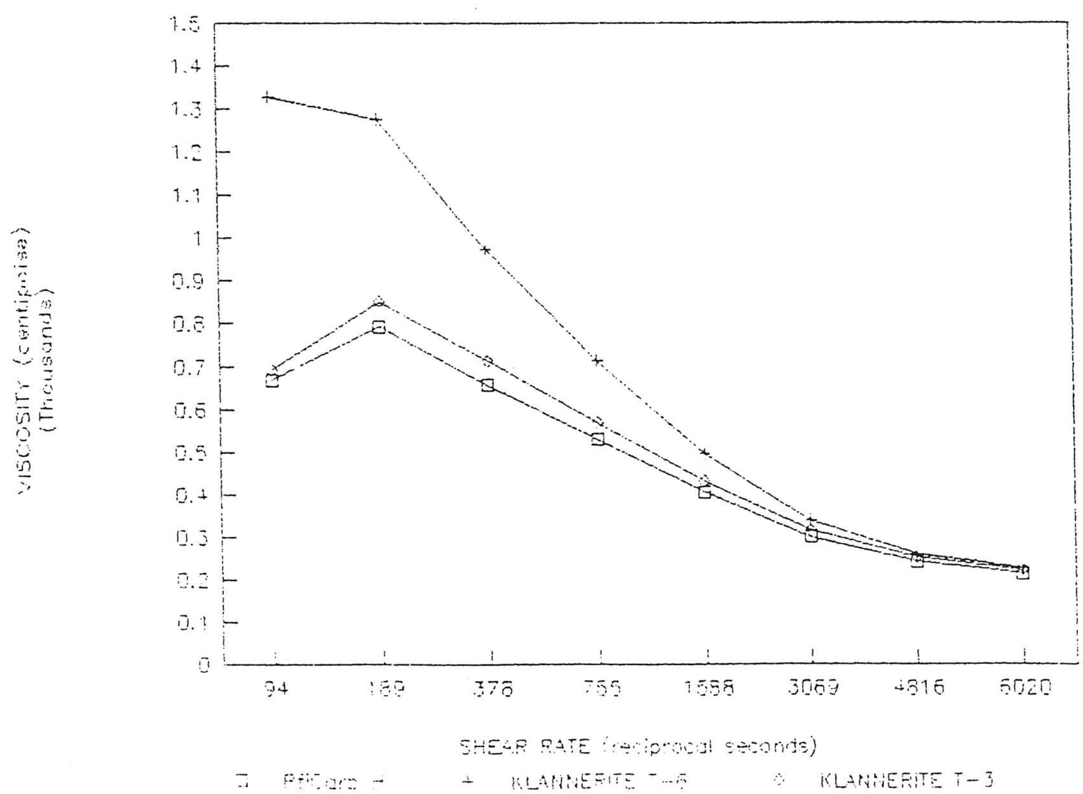
White Alkyd Enamel

		Polygloss 90	KLANNERITE T-6	KLANNERITE T-3
Accelerated Weathering - 300 hours				
Color change	Score	10	10	10
Gloss change	"	10	10	10
Chalking	"	10	10	10
Thermal Reflectivity - Infra Red				
Temperature				
Initial	°F	76	75	75
After 5 minutes		120	135	125
10 "		136	145	140
15 "		140	148	145
20 "		143	150	145
25 "		143	150	145
30 "		143	150	145

WHITE ALKYD ENAMEL



WHITE SEMIGLOSS LATEX



DL LABORATORIES
116 East 16th Street
New York, New York 10003
212·777·4410
212·505·8419 FAX

November 6, 1991

HeatShield Technologies, Inc.
10580 N. W. 41st Street
Coral Springs, FL 33065

Att: **Mr. Paul Arena**
President

DL-8658A

OBJECTIVE

To compare the hiding efficiency of KLANNERITE T-3 and KLANNERITE T-6 vs two commercially available titanium dioxide extender pigments, PfiCarb H and Polygloss 90.

PRODUCTS TESTED

Pigment	Manufacturer
KLANNERITE T-6	HeatShield Technologies
KLANNERITE T-3	HeatShield Technologies
Pficarb H	Pfizer, Inc. (In latex enamel)
Polygloss 90	J. M. Huber Corp. (In alkyd enamel)

FORMULATIONS

The formulations prepared and tested are shown in Appendix I. The KLANNERITE pigments were substituted on an equal weight basis for the competitive pigments.

Appendix IA - White Semi-Gloss Latex Enamel

Appendix IB - White Alkyd Enamel

TEST PROCEDURE

The hiding efficiency of the pigments tested was determined using the DuPont SRATE method. This procedure calculates the spreading rate necessary to achieve total hiding, which is defined as a contrast ratio of 0.98. Note that the higher the spreading rate, the better the hiding efficiency.

TEST RESULTS

White Semi-Gloss Latex Enamel

The pigments tested rank as follows based upon the determined spreading rate necessary to obtain a contrast ratio of 0.98.

Pigment	Spreading Rate
KLANNERITE T-6	250 Ft^2 / Gal.
KLANNERITE T-3	197 " " "
PfiCarb H	170 " " "

White Alkyd Enamel

The pigments tested rank as follows based upon the determined spreading rate necessary to obtain a contrast ratio of 0.98.

Pigment	Spreading Rate
KLANNERITE T-6	429 Ft^2 / Gal.
KLANNERITE T-3	360 " " "
Polygloss 90	358 " " "

LABORATORIES

Att: Mr. Paul Arena
Re: DL-8658A

CONCLUSIONS

1. KLANNERITE T-6 is superior in hiding efficiency to both PfiCarb H in a latex system and Polygloss 90 in an alkyd system, as tested.

2. KLANNERITE T-3 is somewhat superior in hiding efficiency to PfiCarb H in a latex system and equal to Polygloss 90 in a alkyd system, as tested.

D/L Laboratories

Thomas J. Sliva

Thomas J. Sliva
Assistant Technical
Director

CW

APPENDIX IA

FORMULATIONS

WHITE SEMI-GLOSS LATEX

L ——————>	(%)	PfiCarb H	KLANNERITE T–6	KLANNERITE T–3
Propylene Glycol		60.0	——————————>	
Foamaster VL		1.0	——————————>	
Tamol SG–1		7.0	——————————>	
Water		70.0	——————————>	
TiPure R–900		100.0	——————————>	
Pficarb H		105.0	—	—
KLANNERITE T–6		—	105.0	—
KLANNERITE T–3		—	—	105.0
		Disperse on a high speed disperser		
Water		175.0	——————————>	
Rhoplex AC–64	(60.5)	316.7	——————————>	
Texanol		9.5	——————————>	
Nuosept 95		1.0	——————————>	
Foamaster VL		3.0	——————————>	
Water		29.7	——————————>	
		Adjust pH to 10.0		
Ammonium Hydroxide	(28.0)	3.2	5.0	7.0
Acrysol RM–5 }	(30.0)	55.0	——————————>	
Water } Premix		50.0	——————————>	
		Adjust pH to 8.4 ± 0.2		
Water		6.2	4.5	5.7
Ammonium Hydroxide	(28.0)	3.3	3.5	—
TOTAL WEIGHT	Lbs	995.6	995.9	995.6
TOTAL YIELD	Gals	99.9	100.1	100.1

APPENDIX IB

FORMULATIONS

WHITE ALKYD ENAMEL

A ——>	(%)	Polygloss H	KLANNERITE T-6	KLANNERITE T-3
Cargill 5070	(70)	236.0	——>	——>
Nuosperse 657		3.0	——>	——>
TiPure R–960		210.0	——>	——>
Polygloss 90		175.0	——>	——>
KLANNERITE T–6			175.0	
KLANNERITE T–3				175.0
		Disperse on a high speed disperser		
Mineral Spirits		130.0	——>	——>
Cargill 5070	(70)	244.0	——>	——>
Cobalt Nuxtra	(6)	1.7	——>	——>
Zirconium Nuxtra	(6)	5.6	——>	——>
Calcium Nuxtra	(4)	1.9	——>	——>
Exkin 2		1.0	——>	——>
TOTAL WEIGHT	Lbs	1008.2	——>	——>
TOTAL YIELD	Gals	96.7	——>	——>

DL LABORATORIES
116 East 16th Street
New York, New York 10003
212·777·4410
212·505·8419 FAX

December 2, 1991

Post-It™ brand fax transmittal memo 7671	# of pages ▸ 2
To Paul Arena	From SAUL SPINDEL
Co.	Co.
Dept.	Phone #
Fax # 305 726 6405	Fax # 212 505 8419

HeatShield Technologies, Inc.
10580 N.W. 41st Street
Coral Springs, FL 33065

Att: **Mr. Paul Arena**
President

DL-8658

OBJECTIVE

To determine the heat resistance of PDC coating.

PRODUCT TESTED

The coating tested was identified as:

Heatshield PDC Latex Coating.

PROCEDURE

The coating was diluted 3 to 1 with deionized water, filtered through a coarse paint strainer, then applied to 6"x 12"x 0.020" aluminum panels using an adjustable doctor blade. The dry film thickness of the coated panels averaged 9 mils. The test panels were baked at 500°C for one hour and allowed to condition over night before testing.

The heat resistance test consisted of subjecting the panels to a direct flame of approximately 3500°F, as generated at the apex of the inner cone of a Bernz O Matic propane torch. The difference in time to burn through coated and uncoated aluminum panels was recorded.

TEST RESULTS

The following observations were made:

1. The diluted coating had a pH of 11.75, and a viscosity of 57KU as measured according to ASTM test method D-562.
2. The uncoated aluminum panel burned through within 4 minutes.
3. The PDC coated aluminum panel did not burn through after 30 minutes of exposure to the Bernz O Matic torch.
4. When the reverse side of the coated PDC panel, (the uncoated side), was subjected to the torch, it burned through within 4 minutes.

CONCLUSION

The PDC coating exhibits significant heat resistance, inasmuch as it delayed the penetration of a high temperature flame thru an aluminum panel by over 700% as compared to an uncoated aluminum panel.

D/L Laboratories

Saul Spindel
President

CW

DL LABORATORIES
116 East 16th Street
New York, New York 10003
212·777·4410
212·505·8419 FAX

January 6, 1992

HeatShield Technologies, Inc.
10580 N. W. 41st Street
Coral Springs, FL 33065

Att: Mr. Paul Arena

DL-8872

OBJECTIVE

To determine the oil absorption of two grades of KLANNERITE pigment.

PRODUCT TESTED

KLANNERITE T-3	1.5 to 25 microns
KLANNERITE T-6	1 to 5 microns

TEST PROCEDURE

ASTM D-281 - Oil Absorption of Pigments by Spatula Rubout

TEST RESULTS

The pigments exhibited an oil absorption as follows:

KLANNERITE T-3	37
KLANNERITE T-6	49

D/L Laboratories

Mario Lazaro, Jr.
Group Leader

CW

RECEIVED
[illegible] 12 [illegible]
THE TRILLIUM CORP.

Cominco American

Mr. Phil Stouffer
The Trillium Corporation
4183 Meridian Street
Bellingham, Washington 98226

February 9th, 1987

Dear Mr. Stouffer:

I enclose chemical and X-ray diffraction analyses of the sample you left at the Exploration Research Laboratory in Vancouver. As we discussed on the telephone, these show that the dominant chemical species present is silicon dioxide and that its crystal form is alpha cristobalite.*

The dominant impurities are Al_2O_3, MgO, and CaO, with about 4% of water. I suspect that these take the forms of (in decreasing order of abundance) quartz, kaolin or some similar clay, muscovite, and perhaps relict traces of feldspars. Amorphous aluminum oxide may also be present.

In hand specimen the rock is white, with very minor amounts of iron oxide (orange) staining on fractures and in cavities. It is dull and earthy. The only macroscopic crystals are rare (much less than 1% by volume) quartz grains 1 to 2 mm long. They have the square shape of beta quartz. They have irregular, frosted faces, suggestive of alteration.

Under the binocular microscope, the mass has iridescence and sparkle, suggesting that the cristobalite grains are pristine, but are very small.

The only publicly-available geologic maps of the area are at small scale; these show the region to be an extensive volcanic terrain. I guess that the rock is the altered remnant of a precursor rhyolitic volcanic rock. The alteration could have been simple weathering, but also may have been the more intense alteration related to circulation of hot waters.

I sent the second sample out for brightness analysis. I also would like to see the shape of the cristobalite grains, so I've asked for thin sections. If that doesn't show anything, we'll try scanning electron microscopy.

Sincerely Yours:

[signature]

F. William Burnet
Project Manager, Industrial Minerals

Encl: X-ray tracing, chemical analysis

* subsequently Modified to pseudo-morphic ^ poly-morphic of α Tridymite

DEVELOPMENT-CAI

JOB V 87-0017R

LAB NO	FIELD NUMBER	SiO2 %	TiO2 %	AL2O3 %	FE2O3 %	FEO %	MNO %	MGO %	CAO %	NA2O %	K2O %	P2O5 %	LOI %	TOTAL %
R8700238	CRIS	89.63	.43	3.77	.03		.02	.49	.42	.02	.17	.02	4.32	99.32

I=INSUFFICIENT SAMPLE X=SMALL SAMPLE E=EXCEEDS CALIBRATION C=BEING CHECKED R=REVISED
IF REQUESTED ANALYSES ARE NOT SHOWN /RESULTS ARE TO FOLLOW

ANALYTICAL METHODS

FEO DETERMINED BY ACID DIGESTION /VOLUMETRIC.LOI DETERMINED GRAVIMETRICALLY

OTHER ELEMENTS BY LI BORATE FUSION/XRF. WHERE NO FEO VALUE SHOWN 'FE2O3' IS TOTAL FE AS FE2O3

RECEIVED
APR - 3 1987
THE TRILLIUM CORP.

Cominco American

Mr. Phil Stouffer
The Trillium Corporation
4183 Meridian Street
Bellingham, Washington 98226

March 30th, 1987

Dear Phil,

I enclose my sketch map of the Vita Luz Mine. The area is a zoned system of hydrothermally altered rocks. The original rock was a rhyolitic tuff; it may be part of the regionally-extensive Peach Springs Tuff.

The fault on the western side was the plumbing system that the hot, corrosive waters followed. The most intense alteration (the blue-grey unit) occurred in the rocks close on the upper side of the fault. The least altered rocks are those to the northeast.

The white cristobalite unit is altered to an intermediate degree. Where it is exposed on surface, the white rock occupies an area of about 350 feet by 100 feet. The average vertical extent is about 75 feet. About 2.6 million cubic feet of white rock occur in the area. I did not take a large enough sample for determining the rock density, but an estimate of 20 $ft.^3$/ton is fairly close. In comparison, a massive marble or quartz sandstone is about 12 $ft.^3$/ton, while pumice is about 35 $ft.^3$/ton.

This suggests that 135,000 tons of the white rock occur above the elevation of the pit floor. Although the white unit seems to be abruptly truncated to the northwest of the pit area, it is reasonable to assume that it extends 20 feet below the pit floor. This additional, assumed vertical extent adds 25%, or 35,000 tons, to the estimate.

If the moderately altered rock contains sufficient cristobalite to achieve the desired optical effects, then the tonnage of near-surface ore could increase to about 400,000 to 500,000 tons.

The reserves could also be increased somewhat by drilling vertical holes in the vicinity of sample locations #5, 7, 8, and 12. I have sent the samples out for x-ray, thin section, and chemical analysis, and I will forward the results to you.

Sincerely Yours

F. William Burnet
Project Manager, Industrial Minerals

encl: map

Tan, green, or buff moderately altered tuff; lithic fragments common

white, intensely altered tuff; lithic fragments ghostly to absent

transitional zone between white altered tuff and blue-grey rock

blue-grey massive chert or chalcedony

unaltered tuff or crystalline basement

quartz veinlet

fault

road

base map: U.S.G.S. Warm Springs SE 7½' quadrangle

Contour interval: 40'

COMINCO AMERICAN INCORPORATED

COMPILED BY FWB/OR		DRAFTED BY FWB	
REVISED BY	DATE	REVISED BY	DATE

Geologic Sketch Map
Vita Lutz Mine Area
Mohave County, Arizona

SCALE: approx. 1" = 120' | DATE: March 13th, 1987 | PLATE:

RESEARCH REPORT

CENTER
FOR
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RESEARCH

RETT & BOWSER ROADS
P.O. BOX 909
PISCATAWAY, NJ
08855-0909
201/932-5900
201/932-4817
FAX: 201/932-3258

EXAMINATION OF KLANNERITE

for

HEATSHIELD TECHNOLOGIES, INC.
8400 N. University Dr., Suite 316
Tamarac, Florida

****

November 15, 1991

****

RESEARCH REPORT

Date November 22, 1991

Subject: Klannerite

cc: Paul R. Arena (3)

Viva Luz Mine, Mojave County, AZ

Heatshield Technologies, Inc.
Tamarac, Florida

Examination of Klannerite

Introduction. A very unique mineral deposit containing a high percentage of cristobalite, a high temperature polymorph of silica (SiO_2), was found near Kingman, Arizona. This mineral called Klannerite is from the Viva Luz Mine, Mojave County, Arizona. Most natural deposits the world over contain silica in the form of quartz as very large single crystals either clear, smoky or amethyst in Brazil, quartzites or conglomerates in many areas in the United States, or as very fine grained crystallite material as novaculite as found in Arkansas.

This Klannerite mineral when ground to a fine powder imparts very useful properties when used in products of the paint, plastic, and paper industries. It is the purpose of this work to further characterize the mineral and determine if it might open other application areas for the economic development of Klannerite.

Experimental. Since a considerable amount of work has been done by various sources since the discovery of Klannerite, it appeared prudent to obtain a representative sample for evaluation and general analysis. For this reason, representative samples of the naturally occurring cristobalite were forwarded to Rutgers University, Department of Ceramics for X-ray diffraction analysis, scanning electron microscopy, and surface and pore size characteristics. A sample was forwarded to Spectrochemical Laboratories, Inc, Pittsburgh, Pennsylvania for a complete chemical analysis including semiquantitative analysis for trace elements.

The work at Rutgers was conducted using a Siemens X-ray Diffractometer 500, an Amray 1400 Research Scanning Electron Microscope, and Micromeritics Mercury Porisimeter Model 9305.

Discussion. Generally, the Klannerite material was found to be composed of approximately 88% silica (SiO_2) and about 10% alumina (Al_2O_3). The primary phase present being cristobalite with lesser amounts of quartz and kaolinite. The loss on ignition of about 4% was probably related to the water in the crystal structure of the clay minerals present. While the crystalline phases found to be present are inert, fire resistant, and will not support combustion, the small loss on ignition would not place the material in a class as a fire retardant. A fire retardant material, such as aluminum hydroxide ($Al[OH]_3$) gives off nearly 35% of its weight as water when it decomposes on heating to 300°C (572°F.) with the absorbtion of energy.

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Crystalline silica may exist in several different polymorphic forms corresponding to different ways of combining the silicon tetrahedral groups with corners shared. Three basic structures each exist in two or more modifications. The most stable forms are low quartz below 573°C (1063°F.); high quartz, 573°C to 867°C(1593°F.); high tridymite, 867°C to 1470°C (2678°F.); high cristobalite, 1470°C to 1723°C (3133°F.); and above 1723°C as a liquid. The inversion or transformation from the low form to the high form, called displacive, involves only minor distortions of the structure and consequently takes place instantaneously with change in temperature at the inversion temperature. The transformation from one form to another, such as quartz to tridymite to cristobalite, involves reorganization of the basic structure and hence takes place extremely slowly. The latter is called a reconstructive transformation. If silica in the crystalline form of quartz is exposed to a high temperature, say above 1470°C for an extended period of time, causing cristobalite to form, on rapid cooling this high cristobalite phase will invert to low cristobalite rather than return to the quartz structure. Figure 3 shows graphically the relationships of these silica polymorphs. Many materials in nature exist in more than one crystalline form, for example, carbon may exist as graphite or as a diamond, depending on the conditions present at the time of crystallization.

Silica is unusual in that is has two additional polymorphs which may be formed under high pressure, as evidenced by the comparatively recent discoveries of Coesite and Keatite, see Figure 5.

X-ray diffraction was conducted on three samples of the Klannerite rock and on one sample which had been ground by Micron Powder Systems, Summit, New Jersey. The X-ray diffraction patterns, Figure 6, showed a very high percentage of cristobalite with the presence of some quartz and kaolinite. In Figure 6, the graph of the X-ray diffraction pattern represented by the blue traces is supplemented by vertical lines emanatining from the base line. These vertical lines, in a color and identified at the top of the graph, represent the JCPDS file pattern or standard pattern for the crystalline phase indicated. The relative height of these lines correspond to the peak heights in the standard pattern.

The X-ray diffraction pattern in Figure 7 also showed the strong presence of cristobalite, but indicated increased amounts of kaolinite and quartz over the pattern in Figure 6. Generally the X-ray diffraction patterns showed the presence of peaks in the 14 to 20Å range indicating the presence of bentonite type materials, peaks at 9.0Å and 2.99Å indicating zeolitic materials such as heulandite, and a shoulder peak at 4.25Å indicating the possibility of tridymite. The finely ground sample would be expected to represent an average of these patterns, but it was noted in Figure 9 to show definite peaks at 9.0Å and 2.99Å not prominent in the other patterns. This may indicate the sample which was ground came from a different location in the mine.

The X-ray diffraction pattern shown in Figure 8 for the hard material identified the presence of quartz with only minor traces of other phases.

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The JCPDS cards for the standard patterns as used in the identification of the crystal phases present are included in the Appendix.

The scanning electron microscope study was conducted on fractured surfaces of the rock and on a polished section. The scanning electron photomicrographs were made of three areas of the sample and taken at 500X and 5000X magnification, see Figures 14, 15 and 16. These photomicrographs revealed many small crystallites present in the range of 1 to 3 microns with considerable fine porosity being observed. The polished section revealed the presence of denser grains, see Figure 17, which were surrounded by a more porous matrix type material. Mapping these areas of dense versus porous did not reveal any differences in elemental distribution. The iron oxide map did not show any indication of concentration variation. The photomicrographs in Figure 17 were taken at 50X and 500X magnification. Additionally, energy dispersive X-ray analysis was conducted on a dense grain shown at the center of Figure 17(a) and a porous area, shown to the to the right of the grain, see Figures 18 and 19. As may be noted from these figures, the matrix or more porous area showed a higher percentage of alumina than the denser grain.

The nature of the porosity was characterized by the mercury porisimeter. Figure 20 showed a plot of the cumulative pore size diameter of the natural rock. 10% of the pores in this sample were found to be larger than 10 microns, 27% larger than 1 micron, and 59% larger than 0.1 micron with 100% larger than 0.01 micron. The apparent porosity was measured on three samples using a five hour boil in water and were found to be 29.1, 35.1 and 17.0%.

The use of Klannerite in paper coatings, as a pigment in paint and as filler in plastics will depend on whether the material will replace a more costly material with equal performance or give improved performance at equal cost. Based on the work by C. J. Nagel describing the unique reflective nature in the visible through infrared it would appear that coatings have a good chance for success. However, applying photon dispersive coatings to furnaces to improve thermal efficiency may be more difficult since the furnace atmosphere, temperature and contaminants may greatly alter the crystallinity and thereby its ability to perform. The ability of a photon dispersive coating to reflect electromagnetic radiation with negligible adsorption is dependent upon the crystal size, geometry, and the orientation of the coating material.

Conclusions. Based on the analyses conducted on the hand samples reported to be representative of the deposit and reports of previous work, the following conclusions may be drawn:

1. Klannerite is a unique naturally occurring material found only in a deposit in Mojave County, Arizona. It contains approximately 88% silica (SiO_2) in the polymorphic crystalline form of cristobalite in the amount of 75 to 85%. Accessory minerals include quartz (SiO_2) and kaolinite ($Al_2O_3 \cdot 2SiO_2 \cdot 2H_2O$) with lesser

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amounts of tridymite (SiO_2), bentonite and zeolitic minerals, the latter similar to heulandite. Variation in phase composition indicated some mixing or blending must be done to produce a uniform product.

2. Klannerite rock has a comparatively high apparent porosity, of the order of 17 to 35%, which was evident in the work under the scanning electron microscope. From this scanning electron microscopic study, the small amount of iron oxide, 0.15%, appeared not to be concentrated in pockets and thus may be difficult to remove magnetically. Actual tests should be conducted on finely ground samples.

3. Tests which have been conducted by paper companies indicated that finely ground Klannerite may be used as a whitener, replacing in part some of the more expensive materials currently used.

4. Considerable interest has been expressed by the paint and plastics industries based on preliminary studies using Klannerite as a pigment and/or filler replacing such currently used materials as titanium dioxide (TiO_2) and Calcite ($CaCO_3$).

5. Another possible use for Klannerite might be as a mild abrasive in high cost to weight ratio products. This application will require further development.

6. To insure the marketing project is on a firm base, a systematic core drilling program should be undertaken to determine the extent and mineralogical nature of this deposit and that the hand samples in this study were representative.

7. All plans for grinding, crushing, sizing and the general handling of Klannerite must be in compliance with EPA as fine respirable silica is regarded as a hazard. Silica materials, such as cristobalite, quartz and tridymite in respirable form on entry into the lungs are known to cause a form of pnuemoconiosis called silicosis.

Edwin Ruh

Edwin Ruh, Ph.D., P.E.

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Table I

Chemical Analysis of Klannerite

Chemical Analysis, Calc. Basis	Spectrochemical Laboratories Inc.	Michigan Technology University WS-2	WS-4	WS-6	British Columbis Res. (Cominco)
Date of Test	8/12/91	6/13/90	6/13/90	6/13/90	7/87
SiO_2 (by Diff.)	88.4	84.1	89.7	83.4	89.6
Al_2O_3	10.6	14.9	9.6	15.8	3.8
TiO_2	0.11	0.50	0.34	0.48	0.43
Fe_2O_3	0.15	0.06	0.06	0.10	0.03
MgO	0.20	0.02	0.02	0.02	0.49
CaO	0.16	0.17	0.13	0.03	0.42
MnO	0.001	n.d.	n.d.	n.d.	0.02
Na_2O	0.23	0.13	0.07	0.11	0.02
K_2O	0.07	0.05	0.07	0.06	0.17
Li_2O	0.01	n.d.	n.d.	n.d.	n.d.
P_2O_5	0.03	n.d.	n.d.	n.d.	0.02
S	0.01	n.d.	n.d.	n.d.	n.d.
Loss on Ignition	4.09	4.87	3.85	4.24	4.32
Loss on Drying	2.7	1.51	0.52	1.71	n.d.

FILE NAME : ROCK

COMPANY : HE HIELDS TECHNOLOGY
10580 NW 41st STREET
CORAL SPRINGS, FLORIDA 33065

DATE: 5/29/91
BY: L.S.GECZI

MERCURY CORRECTION FACTOR (calculator pad)

Ho=	23.00	cm
Po=	4.45	psia
ID(cm)=	0.25	cm
ID(cm2)=	0.06	cm2
Vo=	1.13	cc
V=	0.00	cc
Pc=	4.45	psia

SAMPLE: NATURAL ROCK
SAMPLE WEIGHT: 1.8670 g

NUMBER of READINGS	Hg HEAD CORR.	PRESSURE READINGS (psia)	CORRECTED PRESSURE READINGS	PORE SIZE "D"um		INTRUSION READING (pF)		CUMM. INTRUSION (SUM. pF)	CONVER. FACTOR (cc/pF)	CUMULATIVE (cc)	PORE WT.	VOLUME (cc/g)	% CUM. PORE VOLUME
1	4.45	0.9	5.35	33.64		53.33	LOW	0.00	0.0216	0.00	1.867	0.00	0
2	4.44	1.6	6.04	29.79		53.23	"	0.10	0.0216	0.00	1.867	0.00	0
3	4.44	2.0	6.44	27.96		53.19	"	0.14	0.0216	0.00	1.867	0.00	0
4	4.43	2.9	7.33	24.56		53.10	"	0.23	0.0216	0.00	1.867	0.00	0
5	4.41	8.0	12.41	14.51		52.84	"	0.49	0.0216	0.01	1.867	0.01	7
6	4.39	13.5	17.89	10.06		52.66	"	0.67	0.0216	0.01	1.867	0.01	9
7	4.36	25.1	29.46	6.11		52.22	"	1.11	0.0216	0.02	1.867	0.01	15
8	4.36	15	19.36	9.30	SWITCH	53.55	HIGH	1.11	0.0216	0.02	1.867	0.01	15
9	4.35	32	36.35	4.95		53.51	"	1.15	0.0216	0.02	1.867	0.01	15
10	4.34	44	48.34	3.72		53.36	"	1.30	0.0216	0.03	1.867	0.02	17
11	4.32	81	85.32	2.11		53.08	"	1.58	0.0216	0.03	1.867	0.02	21
12	4.30	114	118.30	1.52		52.94	"	1.72	0.0216	0.04	1.867	0.02	23
13	4.29	174	178.29	1.01		52.82	"	1.84	0.0216	0.04	1.867	0.02	25
14	4.28	234	238.28	0.76		52.72	"	1.94	0.0216	0.04	1.867	0.02	26
15	4.28	289	293.28	0.61		52.62	"	2.04	0.0216	0.04	1.867	0.02	27
16	4.26	370	374.26	0.48		52.42	"	2.24	0.0216	0.05	1.867	0.03	30
17	4.22	519	523.22	0.34		52.00	"	2.66	0.0216	0.06	1.867	0.03	35
18	4.20	656	660.20	0.27		51.69	"	2.97	0.0216	0.06	1.867	0.03	40
19	4.17	864	868.17	0.21		51.33	"	3.33	0.0216	0.07	1.867	0.04	44
20	4.13	1106	1110.13	0.16		50.94	"	3.72	0.0216	0.08	1.867	0.04	50
21	4.11	1365	1369.11	0.13		50.68	"	3.98	0.0216	0.09	1.867	0.05	53
22	4.07	2017	2021.07	0.09		50.25	"	4.41	0.0216	0.10	1.867	0.05	59
23	4.00	5001	5005.00	0.04		49.38	"	5.28	0.0216	0.11	1.867	0.06	70
24	3.96	7760	7763.96	0.02		48.94	"	5.72	0.0216	0.12	1.867	0.07	76
25	3.90	15042	15045.90	0.01		48.15	"	6.51	0.0216	0.14	1.867	0.08	87
26	3.86	20040	20043.86	0.01		47.76	"	6.90	0.0216	0.15	1.867	0.08	92
27	3.82	26940	26943.82	0.01		47.27	"	7.39	0.0216	0.16	1.867	0.09	99
28	3.81	28100	28103.81	0.01		47.16	"	7.50	0.0216	0.16	1.867	0.09	100

Table II. Mercury Porosimeter Data for Klannerite Sample.

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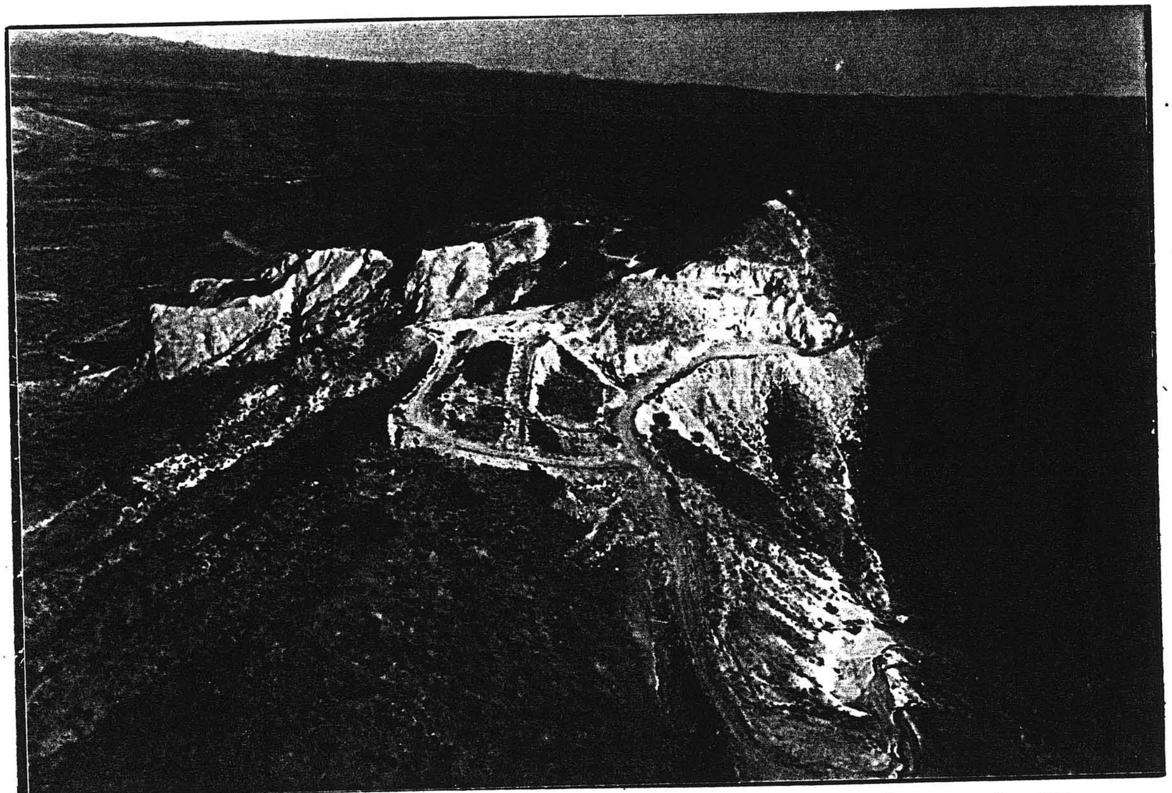


Figure 1. Aerial photograph of the Klannerite deposit at the Vita Luz Mine in Arizona, looking southeast. Klanerite is a highly siliceous rock which is unique in that it contains 75 to 85% cristobalite, a high temperature polymorph of SiO_2. Most minerals high in silica found in nature contain quartz.

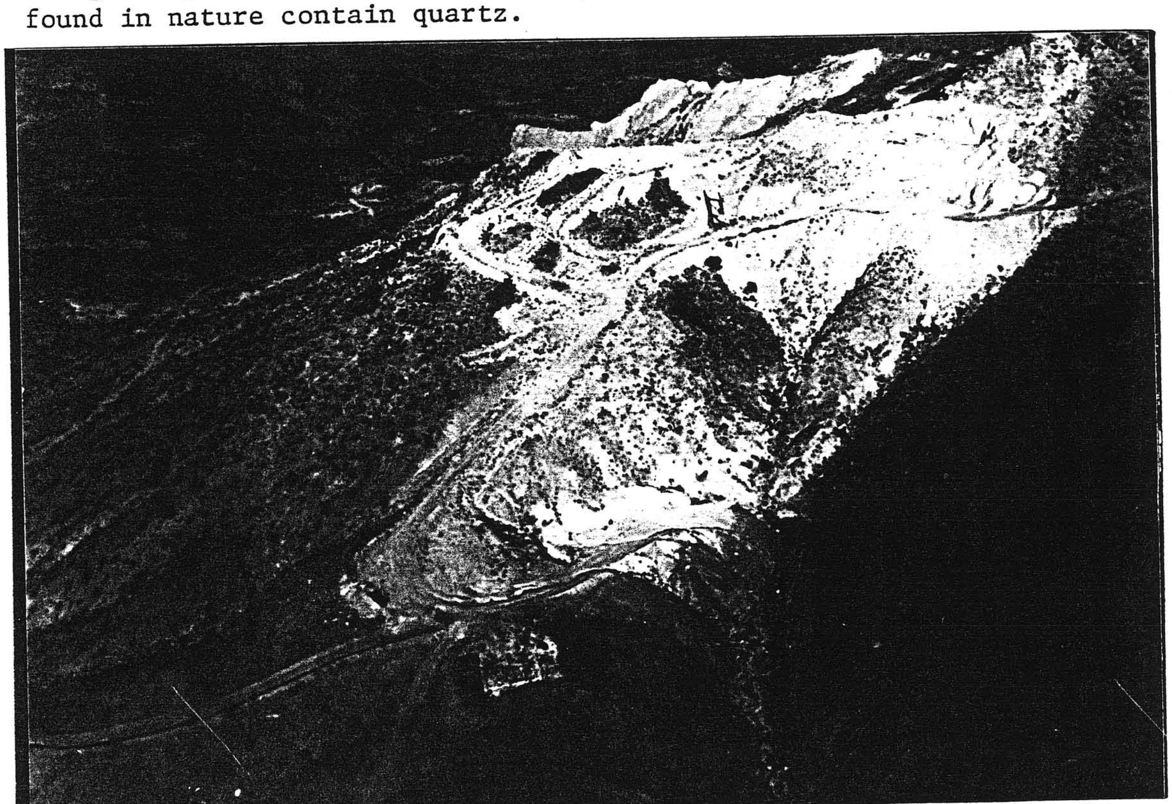


Figure 2. Another aerial view of the Klannerite deposit taken looking slightly south of east.

SiO_2

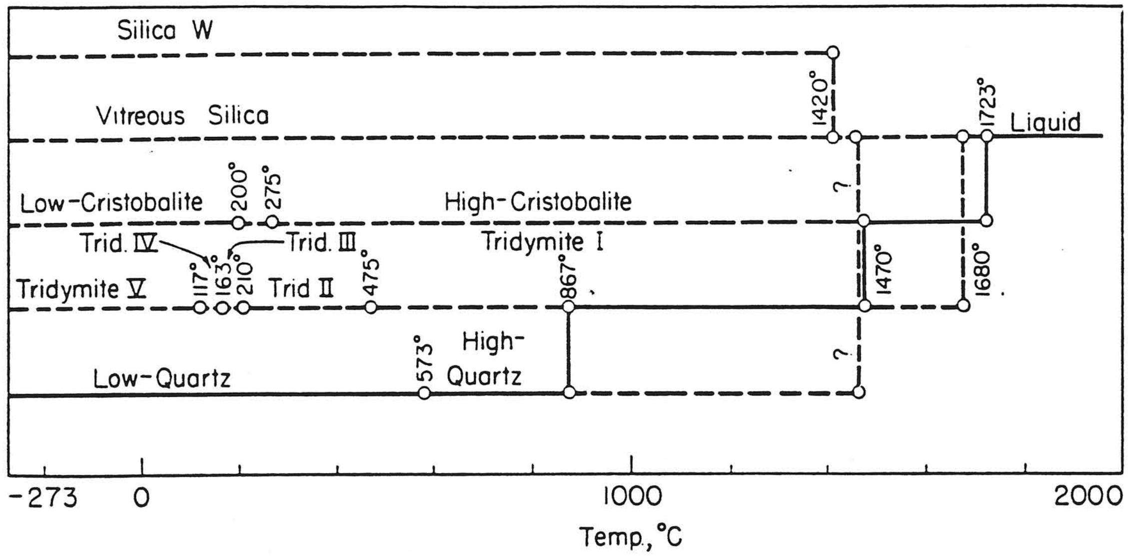


FIG. 153.—SiO_2; stability relations at one atmosphere pressure, as revised in 1955. Ordinate is undefined measure of stability. Solid lines represent stable state; dashed lines represent metastable state.

R. B. Sosman, *Trans. Brit. Ceram. Soc.*, **54**, 663 (1955).

Figure 3. Stability relations of silica at one atmosphere with increasing temperature. "Phase Diagrams for Ceramists", American Ceramic Society, 1964, p. 84. A transformation from Low Quartz to High Quartz or Low Cristobalite to High Cristobalite is extremely rapid usually referred to as displacive while Quartz to Tridymite to Cristobalite is sluggish and referred to as reconstructive.

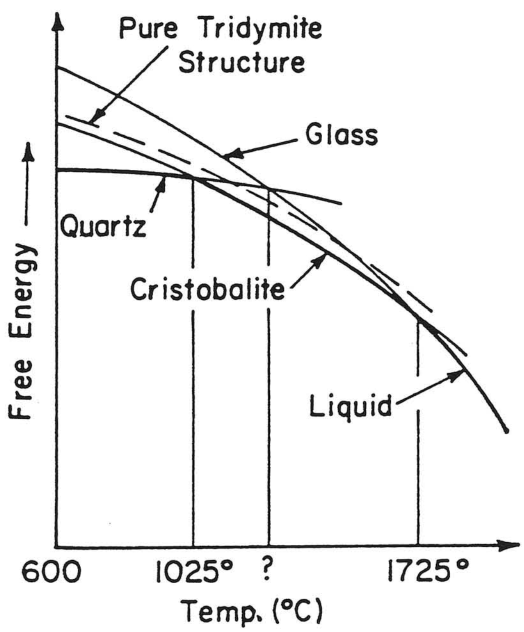


FIG. 154.—SiO_2, free energy for pure phases; schematic. Quartz, cristobalite, and liquid are assumed to be the only thermodynamically stable phases at ordinary pressures. See figures 168 and 184 for stability of tridymite.
S. B. Holmquist, *J. Am. Ceram. Soc.*, **44** [2] 86 (1961); see also, S. B. Holmquist, *Z. Krist.*, **111**, 71–76 (1958).

Figure 4. Schematic diagram showing free energy of the silica phases. Ibid. p. 84.

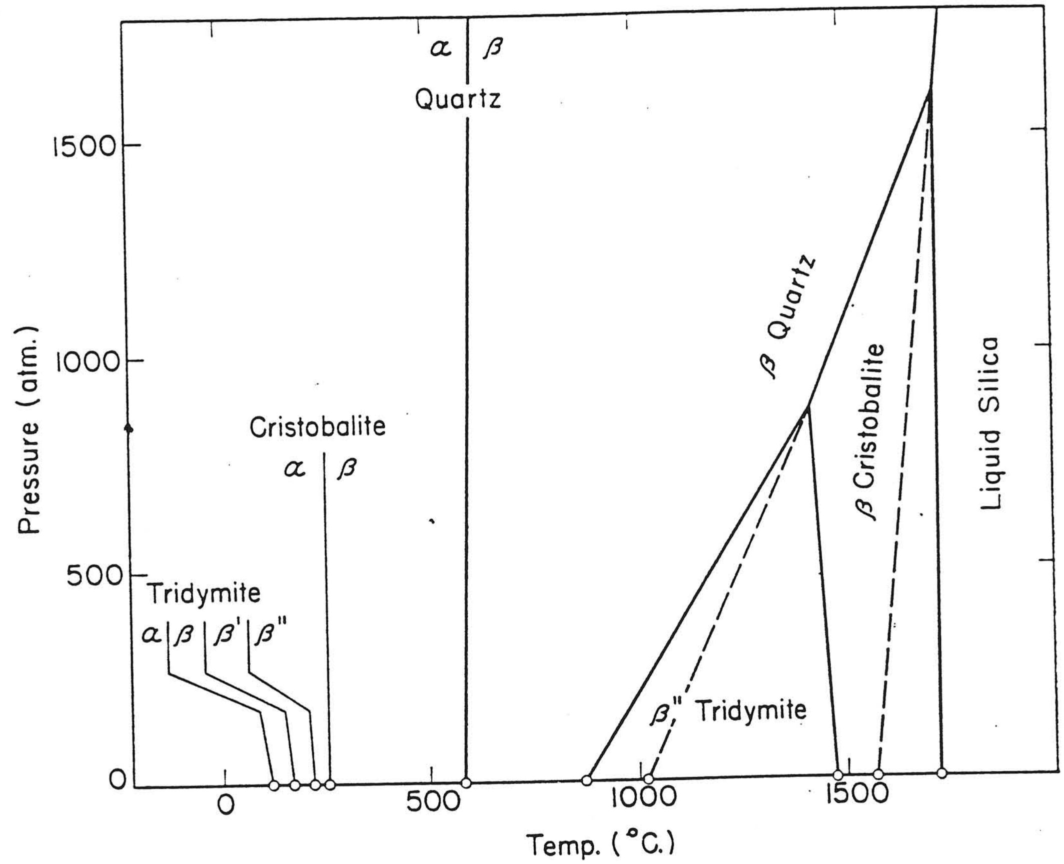


FIG. 155.—SiO_2 (p-t diag.). Solid lines represent transitions of phases stable in the respective adjoining regions. Broken lines represent transitions of metastable phases. Tridymite and cristobalite in the regions of their alpha-beta transitions are each metastable with respect to alpha quartz, which is here the stable phase.

Frank Charles Kracek, "Polymorphism," Encyclopaedia Britannica, Copyright 1953.

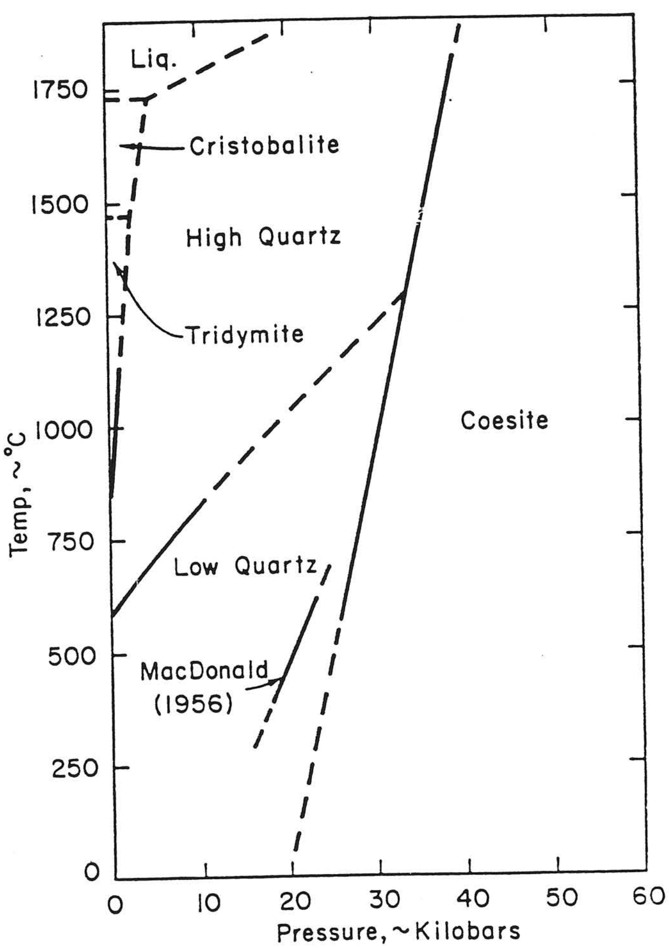
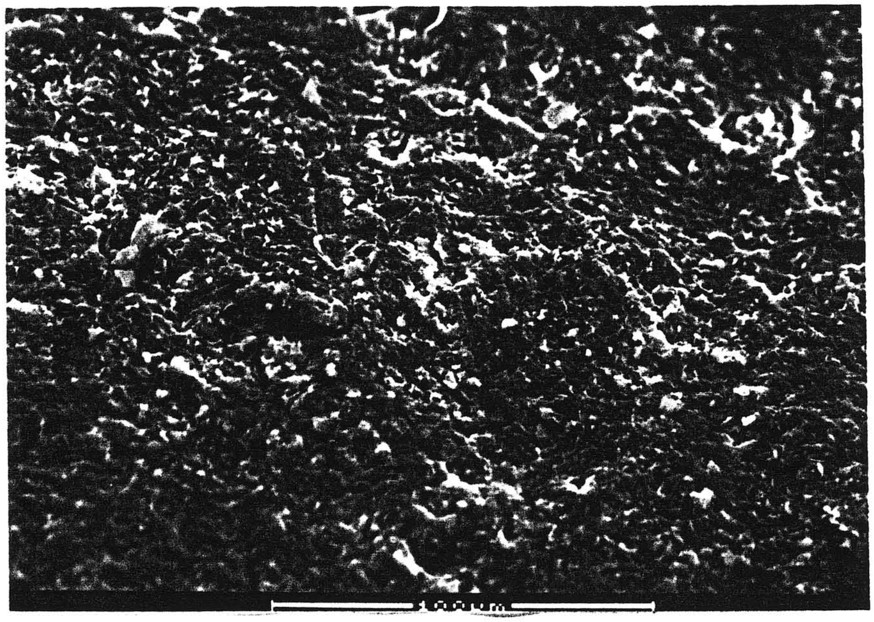


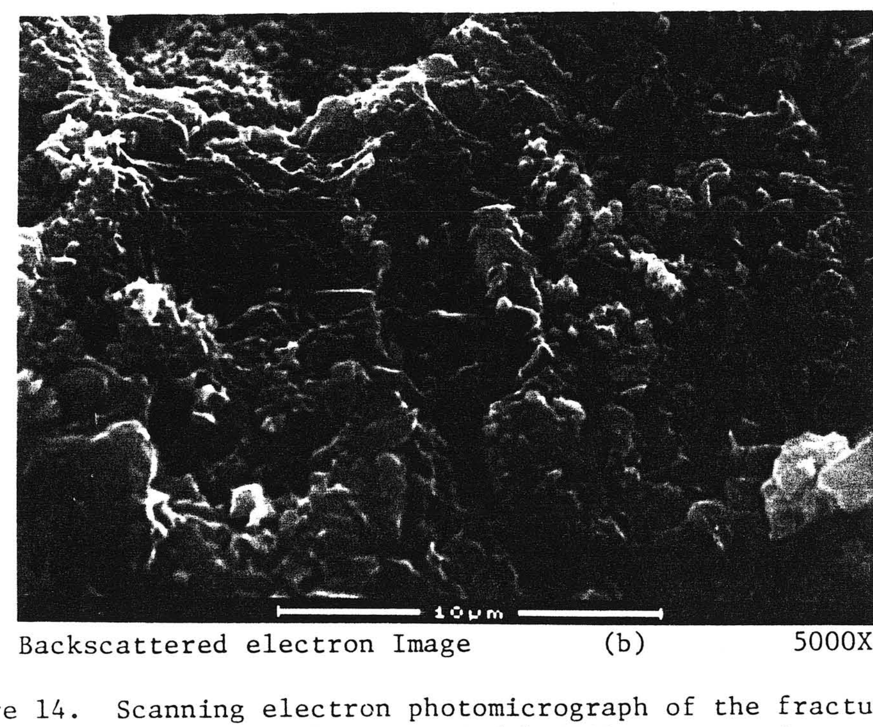
FIG. 156.—System SiO_2; quartz–coesite transition.

F. R. Boyd and J. L. England, *J Geophys. Res.*, 65 [2] 752 (1960).

Figure 5. Effect of pressure and temperature on the transformations of the phases of silica. Ibid. p. 84



Backscattered Electron Image (a) 500X



Backscattered electron Image (b) 5000X

Figure 14. Scanning electron photomicrograph of the fractured surface of Klannerite taken at (a) 500X and (b) 5000X. Note microcrystalline nature of the the fracture with many crystallites 1 to 3 microns.

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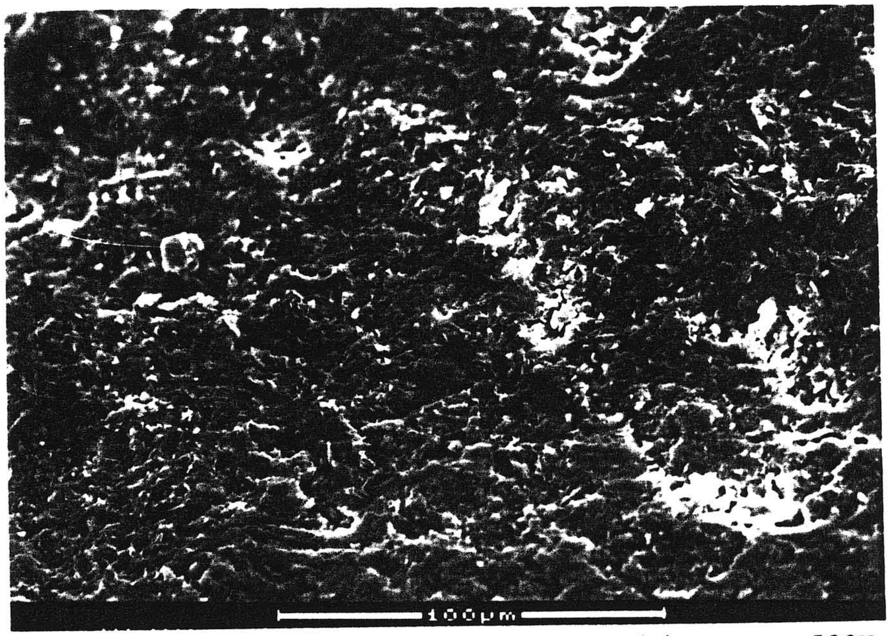
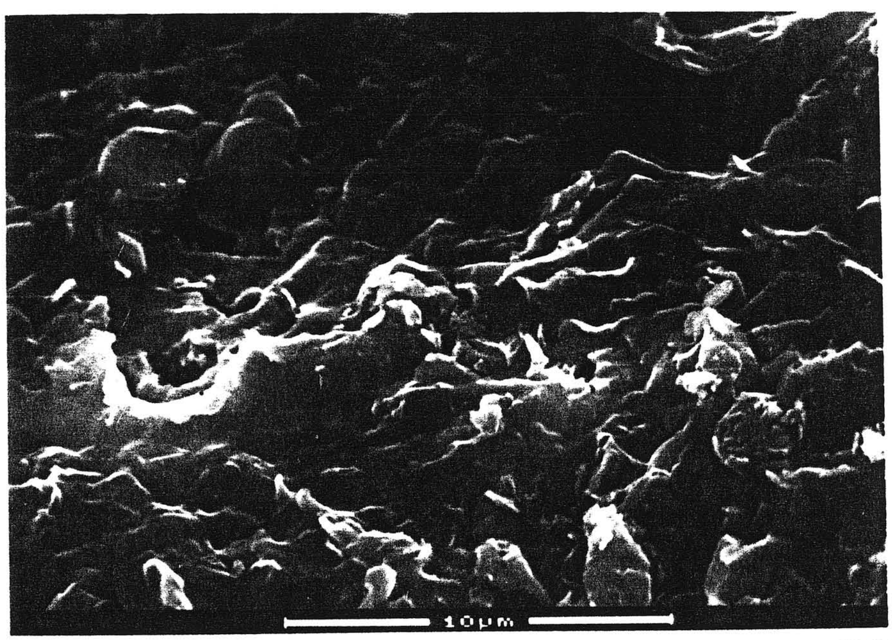


Backscattered Electron Image (a) 500X



Backscattered Electron Image (b) 5000X

Figure 15. Scanning electron photomicrographs of the fractured surface of Klannerite very similar to Figure 14 although there appeared to be some evidence of a glassy bond. Glassy materials do not have a repeated crystal structure and therefore would not have an identifying series of peaks as do crystals with X-ray diffraction analyses.

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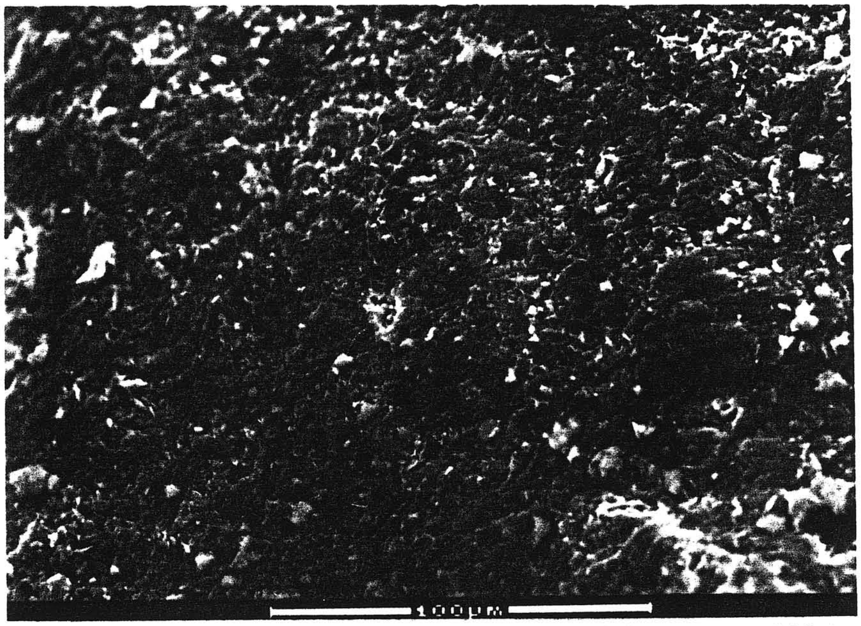
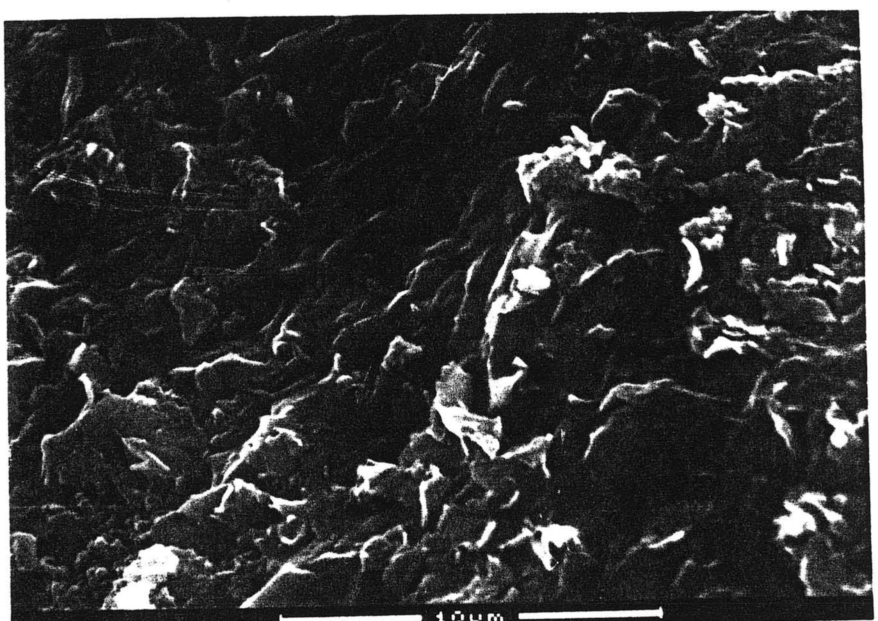


Backscattered Electron Image (a) 500X



Backscattered Electron Image (b) 5000X

Figure 16. Scanning electron photomicrographs of the fractured surface of Klannerite showing very similar features as Figures 14 and 15.

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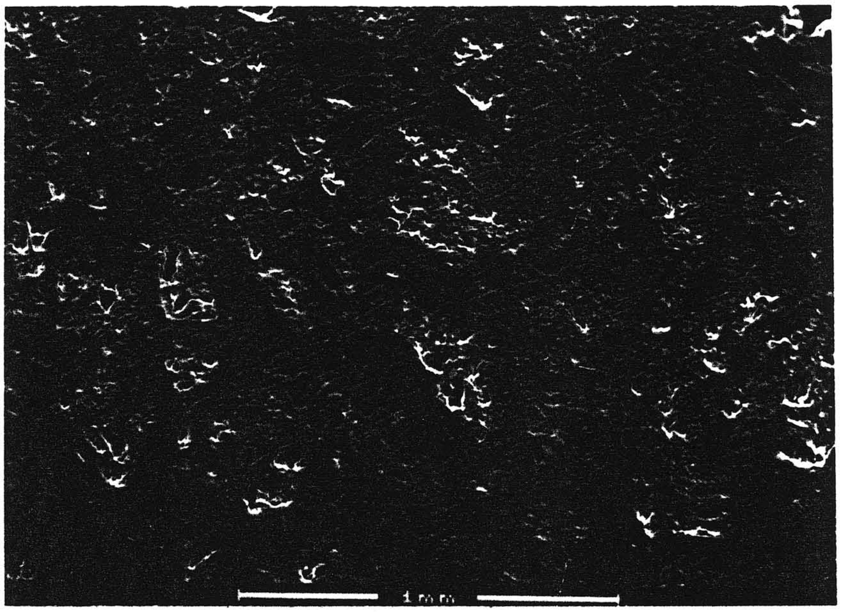
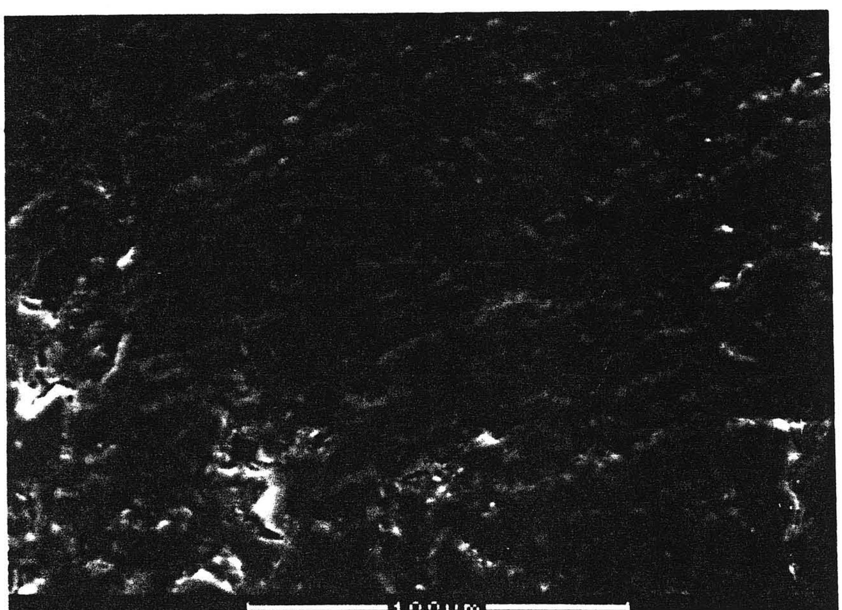


Backscattered Electron Image (a) 50X



Backscattered Electron Image (b) 500X

Figure 17. Scanning electron photomicrograph of a polished section of Klannerite at (a) 50X and (b) 500X. Lower magnification photo revealed denser grains, see center, surrounded by matrix with a porous texture. These denser grains may be quartz as indicated by X-ray diffraction patterns, see Figures 6 through 9. (b) at 500X of the matrix area reveals the porous nature of Klannerite.

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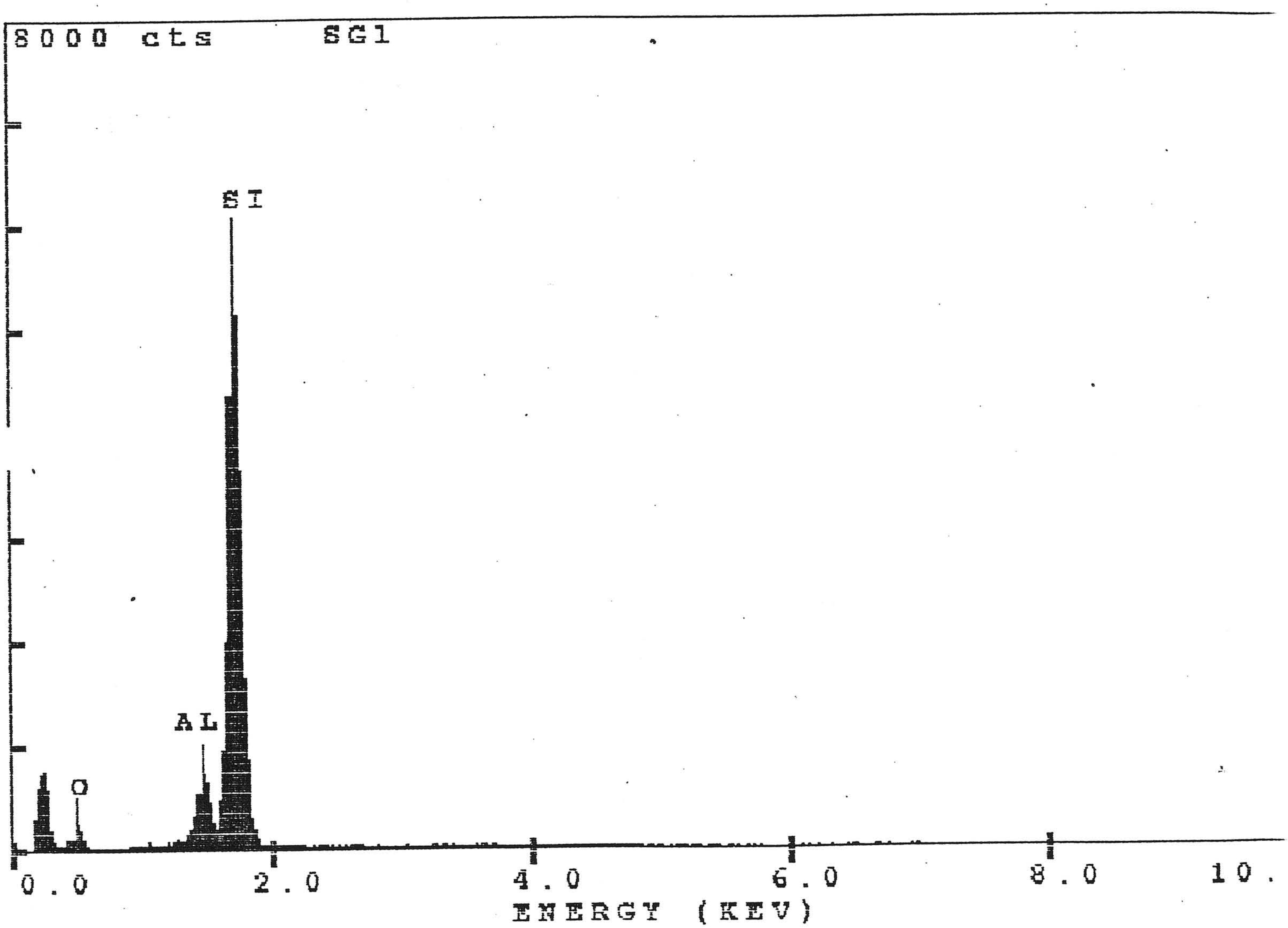


Figure 18. Energy dispersive X-ray analysis of the dense grain shown at the center of Figure 17(a) revealing it to be principally silicon with small amounts of aluminum, both elements present as the oxide.

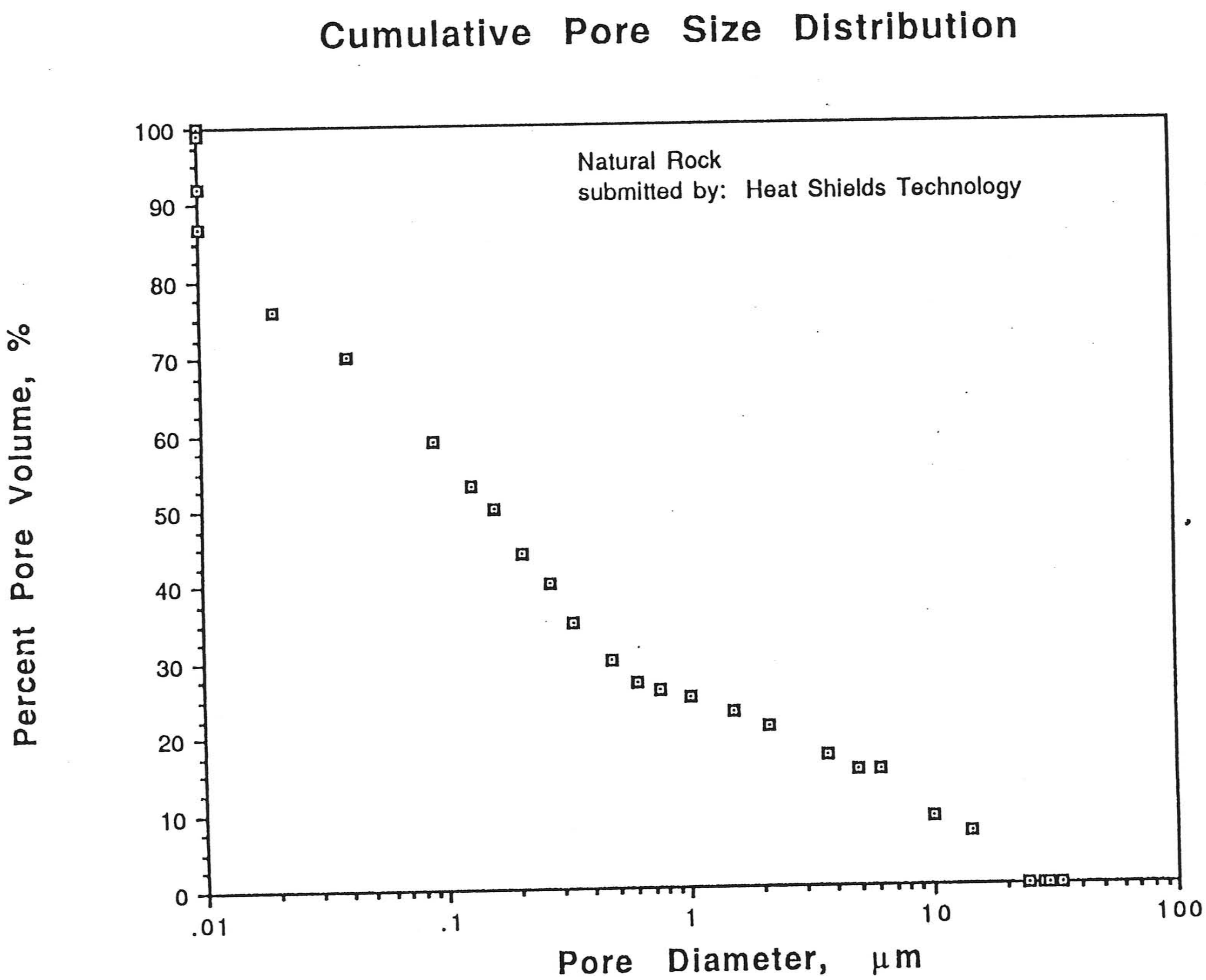


Figure 20. Plot of the cumulative pore size distribution of Klannerite showing 10% of the pores are larger than 10 microns, 27% larger than 1 micron, 59% larger than 0.1 micron and 100% larger than 0.01 micron.

Date November 15, 1991

Subject: Examination of Klannerite

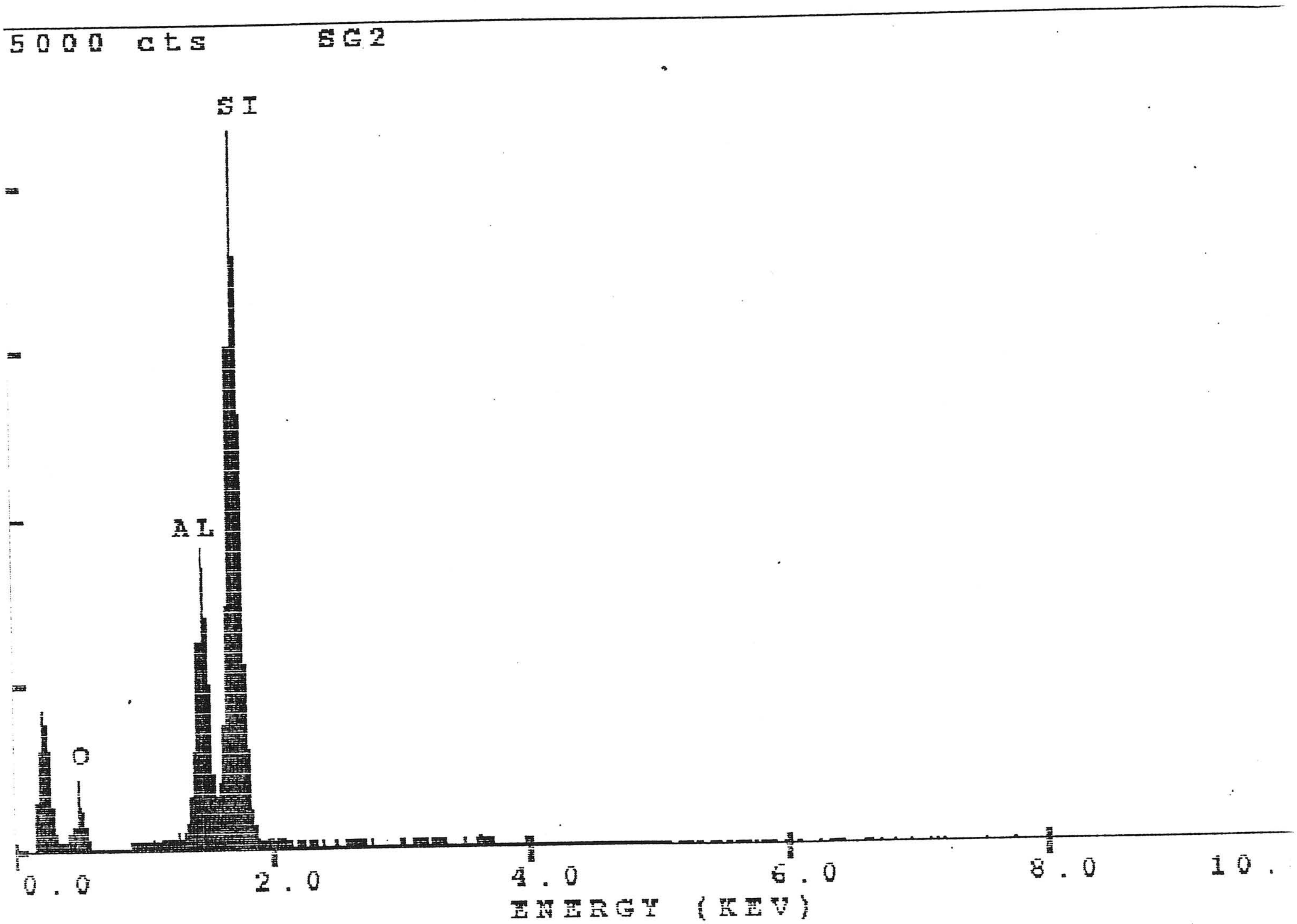


Figure 19. Energy dispersive X-ray analysis of the "matrix" area shown in Figure 17(b) indicating a higher alumina content than for the dense grain in Figure 18.

11-695 JCPDS-ICDD Copyright (c) 1989 Quality: i DELETED

SiO_2

Silicon Oxide

Cristobalite, syn

Rad: CuKa1 Lambda: 1.5405 Filter: Ni d-sp:
Cutoff: Int: Diffractometer I/Icor:
Ref: Natl. Bur. Stand. (U.S.), Circ. 539, 10 48 (1960)

Sys: Tetragonal S.G.: P41212 (92)
a: 4.971 b: c: 6.918 A: C: 1.3917
A: B: C: Z: 4 mp:
Ref: Ibid.

Dx: 2.34 Dm: 2.33 SS/FOM: F30=44(.020,34)

ea: 1.484, nwB: 1.487, ey: 1.484, Sign: - 2V:
Ref: Ibid.

Color: Colorless
Pattern was made at 25 C. Sample was prepared at NBS at 1700 C from silica gel. Spectroscopic analysis showed 0.01-0.1% Al, Cu: 0.001-0.01% Fe, Ti: and 0.0001-0.001% Ag, Mg, Sn. Merck Index, 8th Ed., p. 946. O2Si type. PSC: tP12. To replace 1-0438. Deleted by 39-1425. Additional optical data reference: Deer, Howie, Zussman, Rock Forming Minerals, 4 179. Mwt: 60.08. Volume[CD]: 170.95.

d A	Int.	h k l
4.05	100	1 0 1
3.53	4	1 1 0
3.135	11	1 1 1
2.841	13	1 0 2
2.485	20	2 0 0
2.465	5	1 1 2
2.340	1	2 0 1
2.118	5	2 1 1
2.019	3	2 0 2
1.929	5	1 1 3
1.870	7	2 1 2
1.757	<1	2 2 0
1.730	1	0 0 4
1.690	3	2 0 3
1.634	1	1 0 4
1.612	5	3 0 1
1.600	3	2 1 3
1.571	<1	3 1 0
1.567	<1	2 2 2
1.533	3	3 1 1
1.494	5	3 0 2
1.431	3	3 1 2
1.419	3	2 0 4
1.398	3	2 2 3
1.379	<1	3 2 0

d A	Int.	h k l	d A	Int.	h k l	d A	Int.	h k l
1.365	3	2 1 4	1.281	3	3 2 2	1.206	3	4 1 0
1.352	3	3 2 1	1.242	<1	4 0 0	1.188	1	4 1 1
1.346	<1	3 0 3	1.233	1	2 2 4	1.183	1	3 2 3
1.333	3	1 0 5	1.223	3	4 0 1			
1.299	3	3 1 3	1.210	3	2 0 5			

Strong lines: 4.05/X 2.49/2 2.84/1 3.14/1 1.87/1 2.47/1 2.12/1 1.93/1

33-1161 JCPDS-ICDD Copyright (c) 1989 Quality: *

SiO_2

Silicon Oxide

Quartz, syn

Rad: CuKa1 Lambda: 1.540598 Filter: Mono. d-sp: Diff.
Cutoff: Int: Diffractometer I/Icor: 3.6
Ref: Nat. Bur. Stand. (U.S.) Monogr. 25, 18 61 (1981)

Sys: Hexagonal S.G.: P3221 (154)
a: 4.9133(2) b: c: 5.4053(4) A: C: 1.1001
A: B: C: Z: 3 mp:
Ref: Ibid.

Dx: 2.65 Dm: 2.66 SS/FOM: F30=77(.013,31)

ea: nwB: 1.544, ey: 1.553, Sign: + 2V:
Ref: Ibid.

Color: Colorless
Pattern at 25 C. Sample from the Glass Section at NBS, Gaithersburg, Maryland, USA, ground single-crystals of optical quality. O2Si type. Quartz group. Silicon used as internal standard. PSC: hP9. To replace 5-490. Plus 6 reflections to 0.9089. Additional optical data reference: Swanson, Fuyat, Natl. Bur. Stand. (U.S.), Circ. 539, 3 24 (1954). Mwt: 60.08. Volume[CD]: 113.00.

d A	Int.	h k l
4.257	22	1 0 0
3.342	100	1 0 1
2.457	8	1 1 0
2.282	8	1 0 2
2.237	4	1 1 1
2.127	6	2 0 0
1.9792	4	2 0 1
1.8179	14	1 1 2
1.8021	<1	0 0 3
1.6719	4	2 0 2
1.6591	2	1 0 3
1.6082	<1	2 1 0
1.5418	9	2 1 1
1.4536	1	1 1 3
1.4189	<1	3 0 0
1.3820	6	2 1 2
1.3752	7	2 0 3
1.3718	8	3 0 1
1.2880	2	1 0 4
1.2558	2	3 0 2
1.2285	1	2 2 0
1.1999	2	2 1 3
1.1978	1	2 2 1
1.1843	3	1 1 4
1.1804	3	3 1 0

d A	Int.	h k l	d A	Int.	h k l	d A	Int.	h k l
1.1532	1	3 1 1	1.0476	1	1 0 5	0.9873	1	3 1 3
1.1405	<1	2 0 4	1.0438	<1	4 0 1	0.9783	<1	3 0 4
1.1143	<1	3 0 3	1.0347	<1	2 1 4	0.9762	1	3 2 0
1.0813	2	3 1 2	1.0150	1	2 2 3	0.9636	<1	2 0 5
1.0635	<1	4 0 0	0.9898	1	4 0 2			

Strong lines: 3.34/X 4.26/2 1.82/1 1.54/1 2.46/1 2.28/1 1.37/1 1.38/1

29-1488 JCPDS-ICDD Copyright (c) 1989 Quality:

$Al_2Si_2O_5(OH)_4$

Aluminum Silicate Hydroxide

Kaolinite-1Md

Rad: CuKa Lambda: 1.5418 Filter: Ni d-sp:
Cutoff: Int: Diffractometer I/Icor:
Ref: Brindley, G., Penn State University, University Park, Pennsylvania, USA, JCPDS Grant-in-Aid Report, (1977)

Sys: Monoclinic S.G.: C*/*
a: 5.16 b: 8.93 c: 7.39 A: C:
A: B: 104.5 C: Z: 2 mp:
Ref: Robertson, R. et al., Am. Mineral., 39 118 (1954)

Dx: 2.60 Dm: SS/FOM: F20=2(.112,87)

ea: nwB: ey: Sign: 2V:
Ref:

Specimen from Pugu, Tanganyika. Q=impurity, probably quartz. Kaolinite-Serpentine group, dioctahedral subgroup. C.D. Cell: a=7.390, b=8.930, c=5.160, beta=104.50, a/b=0.8275, c/b=0.5778, S.G.=A*/*. PSC: mC34. See original PDF Card for Graphical diffractometer trace. To replace 6-221. Mwt: 258.16. Volume[CD]: 329.68.

d A	Int.	h k l
7.1	100	0 0 1
4.41	60b	1 1 0
3.56	100	0 0 2
2.551	25	1 3 0
2.491	30	2 0 0
2.430	5	
2.375	20	0 0 3
2.327	40	-1 1 3
2.200	5	2 0 1
1.980	10	2 2 1
1.888	6	0 4 2
1.787	6	0 0 4
1.679	12	1 5 0
1.665	16	-2 0 4
1.540	3	1 1 4
1.488	30	0 6 0
1.455	5	3 3 0
1.430	3	0 0 5
1.378	3	0 6 2
1.309	3	2 0 4
1.284	6	-4 0 2

Strong lines: 7.10/X 3.56/X 4.41/6 2.33/4 2.49/3 1.49/3 2.55/3 2.38/2

SiO_2

Silicon Oxide

Tridymite-20H, syn

Rad: Lambda: Filter: d-sp: Guinier
Cutoff: Int: I/Icor:
Ref: Florke, Ber. Dtsch. Keram. Ges., 38 89 (1961)

Sys: Hexagonal S.G.: P
a: 9.92 b: c: 81.5 A: C: 8.2157
A: B: C: Z: 160 mp:
Ref: Hill, Roy, Trans. Br. Ceram. Soc., 57 496 (1958)

Dx: 2.30 Dm: 2.27 SS/FOM: F30=3(.043,233)

ea: 1.471, nwB: 1.472, ey: 1.474, Sign: +, 2V: 76x15'
Ref: Winchell, Elements of Optical Mineralogy, 2 249

Color: Colorless or white
Tridymite shows polytypism, and considerable variation occurs in the weak lines. See original paper by Florke for details. Nepheline group. PSC: hP480. To replace 1-0378. Mwt: 60.08. Volume[CD]: 6945.63.

d A	Int.	h k l
4.527	20	0 0 18
4.268	100	2 0 2
4.075	90	0 0 20
4.002	20	1 0 18
3.832	50	1 0 19
3.800	90	2 0 10
3.609	40	2 0 12
3.432	40	1 1 17
3.374	40	2 0 15
3.337	20	1 1 18
3.277	20	1 0 23
3.229	40	2 1 3
3.162	20	2 1 6
3.067	20	2 1 9
3.001	40	2 1 10
2.986	20	2 1 11
2.955	60	2 0 20
2.939	40	1 0 26
2.830	20	2 1 14
2.762	40	3 0 8
2.591	30	1 0 30
2.534	20	3 0 15
2.493	60	2 1 21
2.480	60	2 2 0
2.454	20	2 2 5

d A	Int.	h k l	d A	Int.	h k l	d A	Int.	h k l
2.367	30	3 1 4	1.782	20	4 1 14	1.517	20	4 0 38
2.331	30	2 2 12	1.771	20	1 1 43	1.509	20	0 0 54
2.303	50	3 0 21	1.714	20	3 1 33	1.442	30	3 1 45
2.286	40	3 1 10	1.708	20	5 0 5			
2.130	30	4 0 5	1.691	40	3 1 34			
2.118	30	2 2 20	1.676	20	5 0 11			
2.111	30	4 0 7	1.635	40	1 1 47			
2.088	40	0 0 39	1.630	30	0 0 50			
2.074	40	4 0 10	1.622	20	2 2 38			
2.045	30	2 1 31	1.604	30	4 2 8			
1.967	20	3 2 3	1.599	30	3 3 13			
1.928	40	2 1 34	1.594	20	3 1 38			
1.870	30	3 0 33	1.546	20	5 0 23			
1.851	30	4 1 7	1.534	30	5 1 6			
1.827	30	4 1 10	1.526	20	3 1 41			

Strong lines: 4.27/X 4.08/9 3.80/9 2.96/6 2.49/6 2.48/6 3.83/5 2.30/5

29-1257 JCPDS-ICDD Copyright (c) 1989 Quality: i

$(Na_2,Ca,K_2)Al_2Si_{10}O_{24}\cdot 7H_2O$

Sodium Potassium Calcium Aluminum Silicate Hydrate

Mordenite

Rad: CuKa1 Lambda: 1.5405 Filter: Ni d-sp:
Cutoff: Int: Diffractometer I/Icor:
Ref: Passaglia, E., Contrib. Mineral. Petrol., 50 65 (1975)

Sys: Orthorhombic S.G.: Cmc21 (36)
a: 18.114 b: 20.514 c: 7.527 A: 0.8830 C: 0.3669
A: B: C: Z: 4 mp:
Ref: Ibid.

Dx: 2.09 Dm: 2.10 SS/FOM: F30=31(.020,47)

ea: nwB: ey: Sign: 2V:
Ref: Winchell, Elements of Optical Mineralogy, 339 (1951)

Color: Colorless
Specimen from Filone della Speranza, Elba, Italy. Pb(NO3)2 used as an internal standard. Molecular % exchangeable cations: Ca 40, Na 48, K 12. Zeolite group, mordenite subgroup. PSC: oC236. Volume[CD]: 2796.96.

d A	Int.	h k l
13.6	18	1 1 0
10.3	5	0 2 0
9.06	100	2 0 0
6.59	14	1 1 1
6.40	17	1 3 0
6.07	4	0 2 1
5.80	18	3 1 0
4.88	3	1 3 1
4.60	2	3 1 1
4.53	30	4 0 0
4.46	2	2 4 0
4.15	8	4 2 0
4.00	70	1 5 0
3.84	7	2 4 1
3.77	4	0 0 2
3.63	3	4 2 1
3.57	4	5 1 0
3.53	2	0 2 2
3.48	45	2 0 2
3.42	11	0 6 0
3.39	35	3 5 0
3.29	3	2 2 2
3.22	40	5 1 1
3.20	35	5 3 0
3.16	2	3 1 2

d A	Int.	h k l	d A	Int.	h k l	d A	Int.	h k l
3.10	4b	4 4 1	2.279	1	5 7 0	1.878	2	7 7 1
3.03	1	0 4 2	2.263	1	6 6 0	1.864	<1	1 1 4
3.02	2	6 0 0	2.232	2	4 8 0	1.851	<1	0 2 4
2.942	5	2 6 1	2.166	2b	1 9 1	1.811	10	10 0 0
2.895	13	4 0 2	2.117	1	0 8 2	1.807	6	9 5 0
2.741	2	1 5 2	2.052	7	5 1 3	1.795	3	7 1 3
2.715	2	5 5 0	2.035	2	7 3 2	1.697	2	6 10 0
2.701	5	1 7 1	2.019	2	4 4 3	1.667	2	0 12 1
2.633	3	3 7 0	1.997	2	8 4 1	1.598	2	8 4 3
2.588	1	5 1 2	1.974	<1	2 6 3	1.547	2	6 10 2
2.565	10	4 6 1	1.954	5	6 8 0	1.528	4b	11 5 0
2.521	7	4 4 2	1.935	3	9 1 1	1.479	2	9 9 1
2.459	4	6 4 1	1.932	3	9 3 0	1.447	4	6 6 4
2.436	2b	0 2 3	1.920	2	4 8 2			
2.294	1	1 7 2	1.882	4	0 0 4			

Strong lines: 9.06/X 4.00/7 3.48/5 3.22/4 3.39/4 3.20/4 4.53/3 13.6/2

25-144 JCPDS-ICDD Copyright (c) 1989 Quality: C

$Ca_{1.23}(Al_2Si_7)O_{18}!6H_2O$

Calcium Aluminum Silicate Hydrate

Heulandite

Rad: CuKa1 Lambda: 1.54050 Filter: d-sp: Calculated
Cutoff: Int: Calculated I/Icor:
Ref: Smith et al., Penn State University, University Park, Pennsylvania, USA, JCPDS Grant-in-Aid Report, (1974)

Sys: Monoclinic S.G.: Cm (8)
a: 17.718 b: 17.897 c: 7.428 A: C:
A: B: 116.42 C: Z: 4 mp:
Ref: Alberti, A., Tschermaks Mineral. Petrogr. Mitt., 18 129 (1972)

Dx: 2.19 Dm: SS/FOM: F30=501(.001,44)

ea: nwB: ey: Sign: 2V:
Ref:

Peak height intensities. Specimen from Faroe Islands. Chemical analysis (wt.%): SiO2 57.17, Al2O3 17.03, Fe2O3 0.04, CaO 7.13, Sr 0.19, BaO 0.31, MgO 0.02, Na2O 1.39, K2O 0.73, H2O 16.71. Zeolite group, heulandite subgroup. C.D. Cell: a=15.874, b=17.897, c=7.428, beta=91.64, a/b=0.8870, c/b=0.4150, S.G.=Im (8). PSC: mC184.92. To be deleted by Z-101, higher FN, good experimental: Bayliss March 1988. Mwt: 695.94. Volume[CD]: 2109.40.

d A	Int.	h k l
11.873	6	-1 1 0
8.948	100	0 2 0
7.934	56	2 0 0
6.800	28	-2 0 1
6.652	15	0 0 1
5.937	8	-2 2 0
5.584	3	1 3 0
5.414	5	-2 2 1
5.339	10	0 2 1
5.258	26	-3 1 1
5.122	41	1 1 1
5.072	29	-3 1 0
4.651	44	-1 3 1
4.367	14	-4 0 1
3.981	79	1 3 1
3.925	25	-4 2 1
3.897	34	2 4 0
3.840	14	2 2 1
3.738	7	-2 4 1
3.712	12	-2 0 2
3.627	3	4 2 0
3.565	17	-3 1 2
3.522	6	-1 1 2
3.474	11	-5 1 1
3.429	32	-2 2 2

d A	Int.	h k l	d A	Int.	h k l	d A	Int.	h k l
3.400	25	-4 0 2	2.669	7	0 4 2	2.343	5	-6 4 2
3.326	14	0 0 2	2.561	4	2 2 2	2.325	2	-2 6 2
3.178	33	-4 2 2	2.535	6	-1 5 2	2.318	2	-3 7 1
3.125	26	5 1 0	2.517	6	-5 3 1	2.302	3	3 7 0
3.077	15	-1 3 2	2.487	7	3 5 1	2.295	3	2 4 2
3.036	7	-5 1 2	2.462	7	-6 4 1			
3.000	19	-3 5 1	2.456	6	-4 0 3			
2.992	19	3 3 1	2.442	9	2 6 1			
2.974	47	1 5 1	2.435	8	-2 0 3			
2.964	55	-3 5 0	2.427	12	4 4 1			
2.888	4	4 0 1	2.384	3	-4 6 0			
2.802	43	5 3 0	2.375	3	-5 5 0			
2.749	5	4 2 1	2.369	5	-4 2 3			
2.732	13	-2 6 1	2.358	6	3 1 2			
2.722	11	0 6 1	2.349	6	-2 2 3			

Strong lines: 8.95/X 3.98/8 7.93/6 2.96/6 2.97/5 4.65/4 2.80/4 5.12/4

29-1499 JCPDS-ICDD Copyright (c) 1989 Quality:

$Na_{0.3}(Al,Mg)_2Si_4O_{10}(OH)_2!xH_2O$

Sodium Magnesium Aluminum Silicate Hydroxide Hydrate

Montmorillonite-21A

Rad: CuKa Lambda: 1.5418 Filter: Ni d-sp:
Cutoff: Int: Diffractometer I/Icor:
Ref: Brindley, G., Penn State University, University Park, Pennsylvania, USA, JCPDS Grant-in-Aid Report, (1977)

Sys: S.G.:
a: 5.2 b: 9.0 c: 21.0 A: C:
A: B: C: Z: 2 mp:
Ref: Brown, G., X-Ray Identification and Crystal Structures of Clay, 192 (1961)

Dx: Dm: SS/FOM:

ea: nwB: ey: Sign: 2V:
Ref:

Specimen from Wyoming, USA. Stored over water, four days. C=impurity, probably cristobalite. 100% relative humidity. Reference indicates monoclinic, beta undetermined. Smectite group, dioctahedral subgroup. C.D. Cell: a=21.000, c=5.200, a/b=2.3333. See original PDF Card for Graphical diffractometer trace. Mwt: 0.00. Volume[CD]: 0.00.

d A	Int.	h k l
21.5	100	0 0 1
10.6	18	0 0 2
4.45	55	1 1 , 0 2
3.15	40	0 0 7
2.56	35	1 3 , 2 0
1.69	8	3 1 , 1 5
1.495	25	3 3 , 0 6
1.325	8	2 6 , 4 0

Strong lines: 21.5/X 4.45/6 3.15/4 2.56/4 1.50/3 10.6/2 1.69/1 1.33/1

Spectrochemical Laboratories, Inc.

Telephone: 412-371-2345
FAX: 412-371-0463

8350 FRANKSTOWN AVENUE
PITTSBURGH, PA. 15221

August 12,1991
Sample Recd. 8-5-91
Our Lab#C0566

Ruh International Incorporated
892 Old Hickory Road
Pittsburgh, PA 15243

Attn: Dr. Ed Ruh

ANALYSIS REPORT

RESULTS IN WEIGHT %

ON AS RECEIVED BASIS

Sample of Klanerite Recd. 8-2-91

H_2O	2.66

ON DRY BASIS

LOI	4.09
S	.011

ON CALCINED BASIS

IN WEIGHT%

Al_2O_3	10.60
TiO_2	.11
Fe_2O_3	.15
MgO	.20
CaO	.16
P_2O_5	.03
Na_2O	.23
K_2O	.07
Li_2O	.01
SiO_2	88.38(by difference)

QUALITATIVE SPECTROGRAPHIC
ANALYSIS WITHOUT STANDARDS

RESULTS IN WEIGHT%

ZrO_2	.05
B_2O_3	.003
V_2O_5	.001
PbO	.001

Spectrochemical Laboratories, Inc.

Telephone: 412-371-2345
FAX: 412-371-0463

8350 FRANKSTOWN AVENUE
PITTSBURGH, PA. 15221

August 12,1991
Sample Recd. 8-5-91
Our Lab#C0566

Ruh International Incorporated

Attn: Dr. Ed Ruh

QUALITATIVE SPECTROGRAPHIC
ANALYSIS WITHOUT STANDARDS

RESULTS IN WEIGHT%

Sample of Klanerite Recd. 8-2-91

MnO	.001
SrO	.001
CuO	.001

Not Detected. Cd, As, Te, P, Sb, Ge, Bi, Be, Mo, Sn, Ag, Zn, Ni, Cr, Ba

SPECTROCHEMCIAL LABORATORIES, INC.

W. S. Bates TLF
Vice President

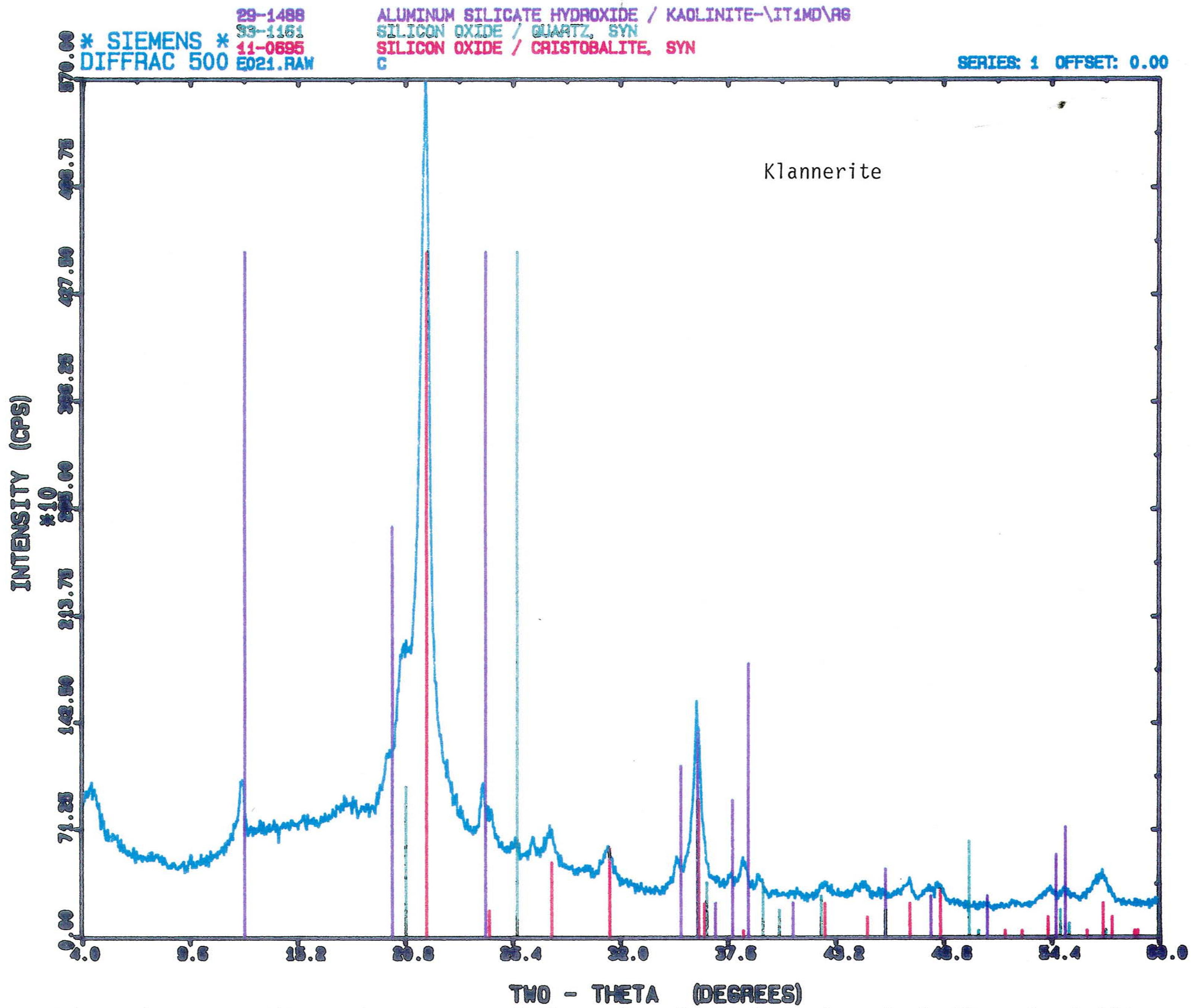


Figure 6. X-ray diffraction pattern of Klannerite showed it to be principally cristobalite with some kaolinite and quartz with minor accessory minerals.

November 1, 1991

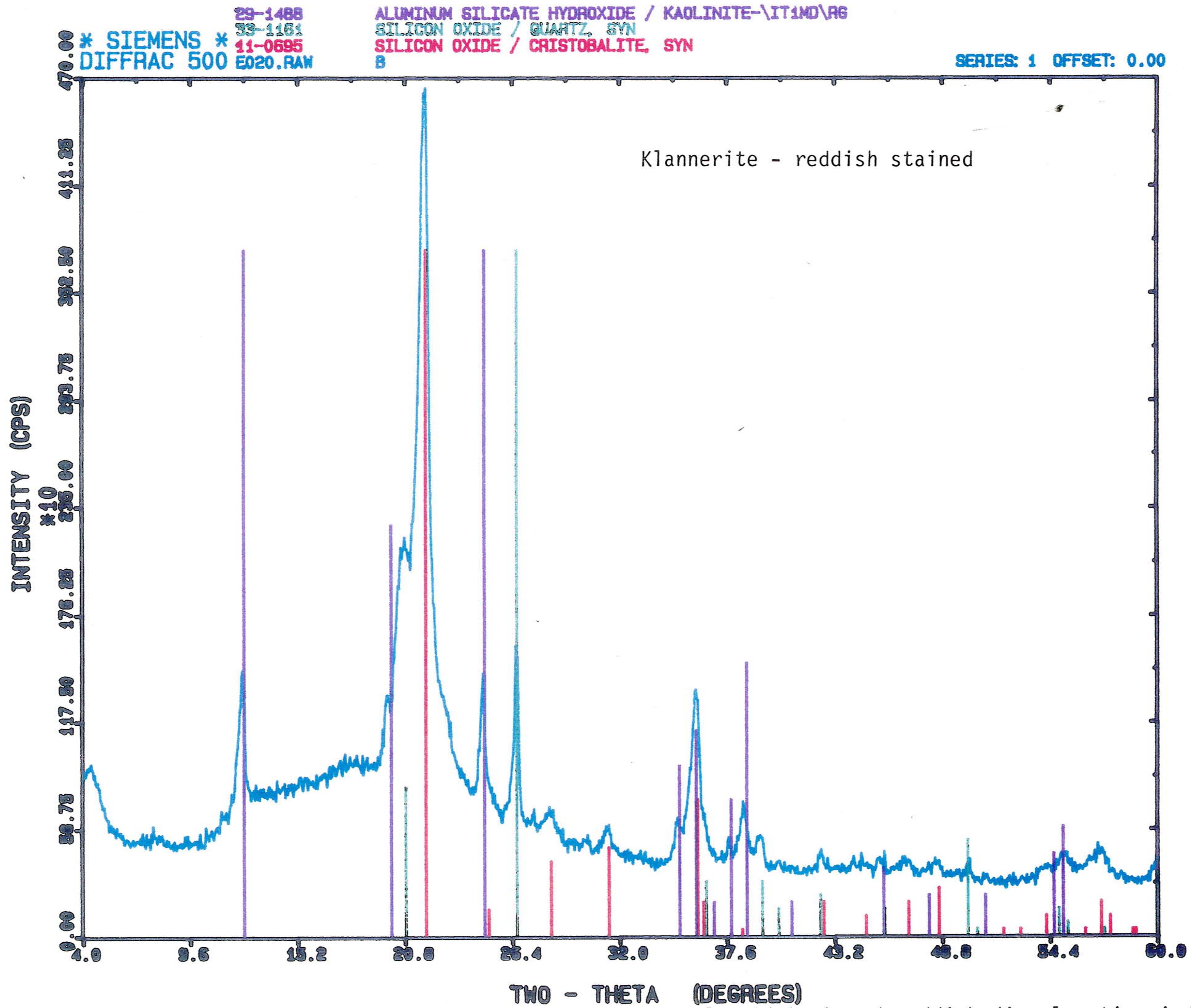


Figure 7. X-ray diffraction pattern of Klannerite sample which showed reddish discoloration indicated principally cristobalite with higher percentages of quartz and kaolinite and minor accessories.

November 1, 1991

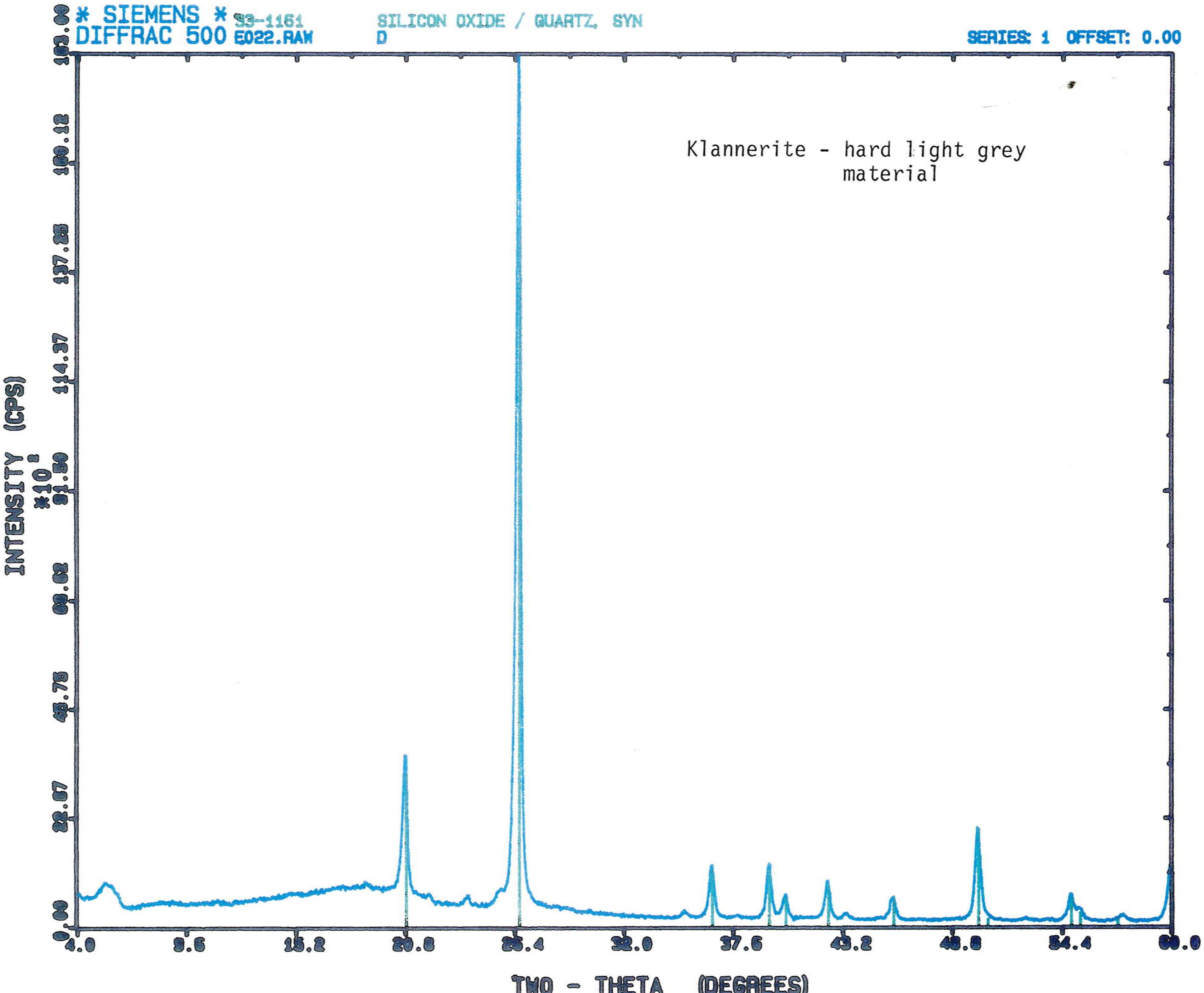
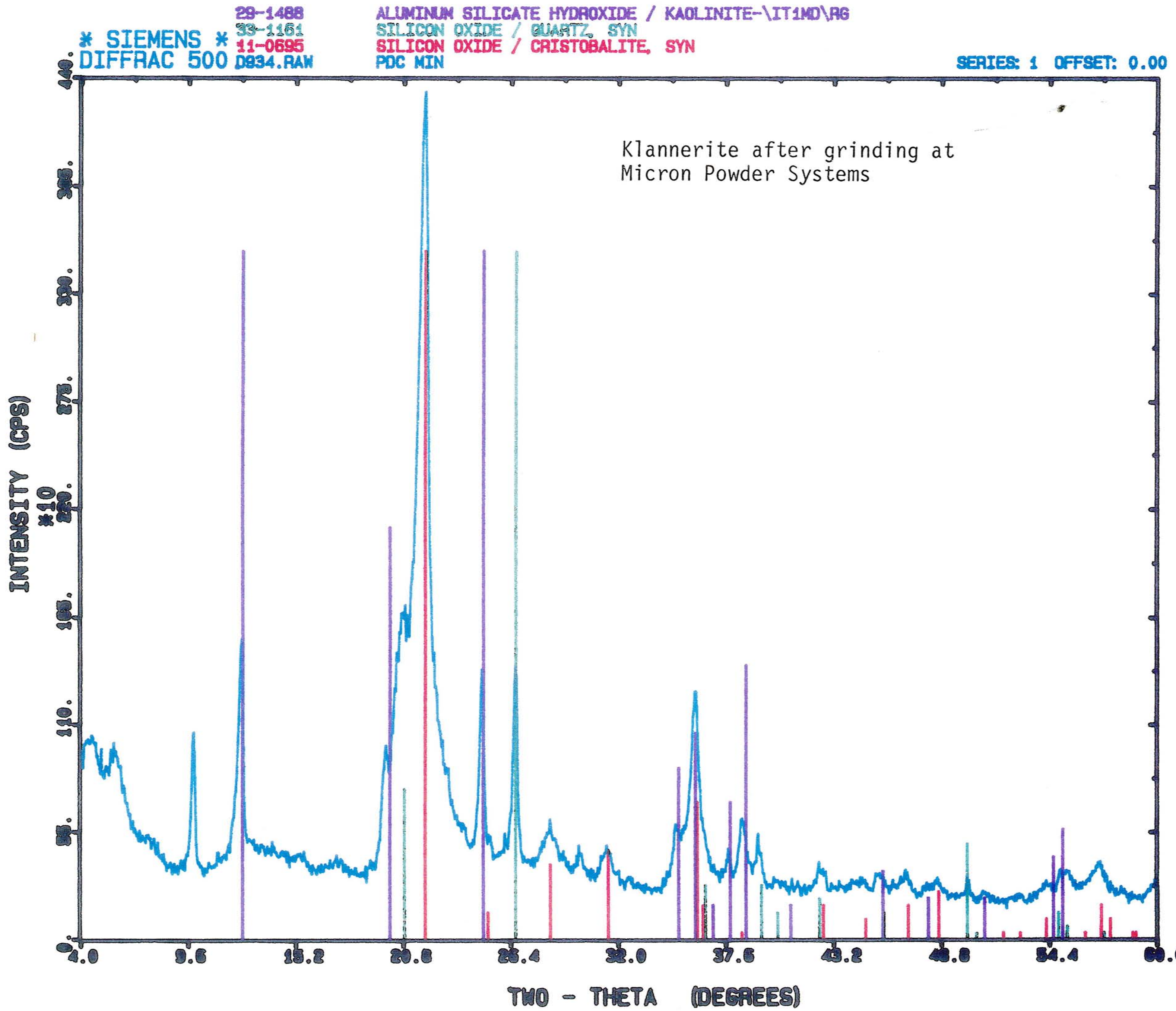


Figure 8. X-ray diffraction pattern of Klannerite sample which was hard light grey was found to be mainly quartz with minor accessory minerals.

November 1, 1991



November 1, 1991

Figure 9. X-ray diffraction pattern of Klannerite after being ground at Micron Powder Systems showed presence of the minerals found in Figures 6 to 8 plus peaks at 14 to 20, 9.0, 4.25 and 2.99Å.

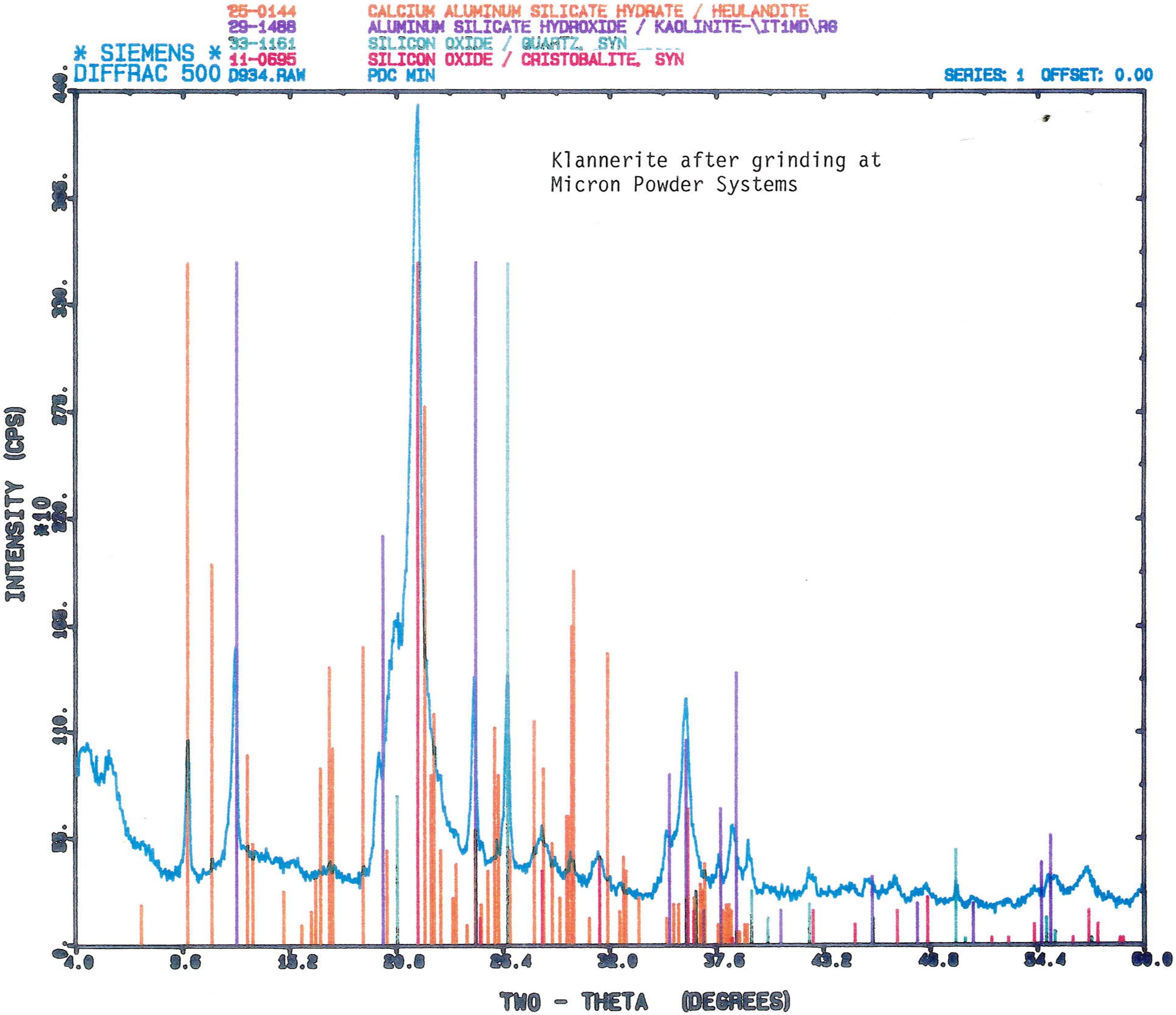


Figure 10. X-ray diffraction pattern of Klannerite after being ground at Micron Powder Systems. Vertical orange lines emanating from the base line represent JCPDS pattern for Heulandite, a Zeolite.

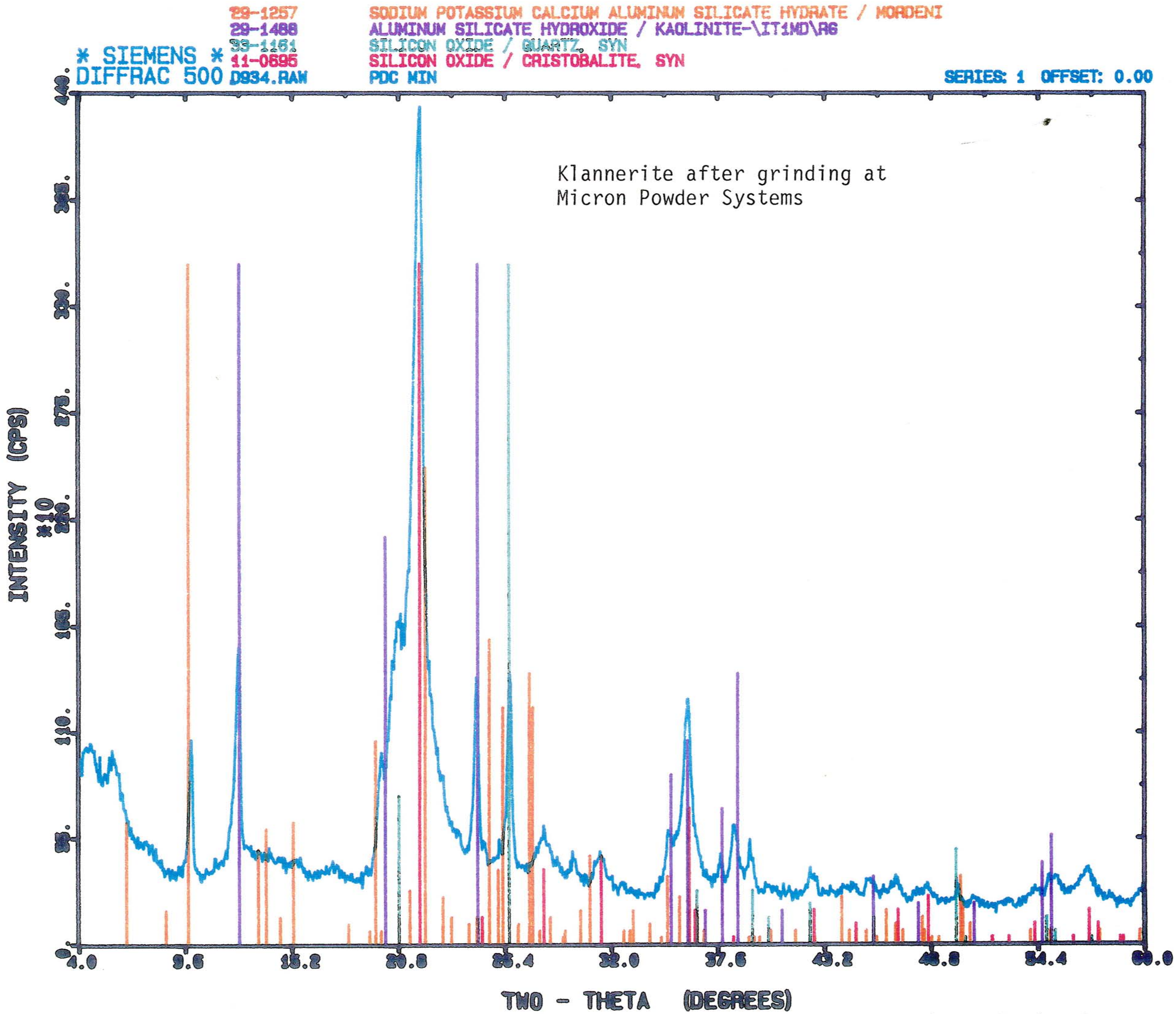


Figure 11. X-ray diffraction pattern of Klannerite after being ground at Micron Powder Systems
Vertical lines emanating from base line represent JCPDS pattern for Mordenite, a sodium Zeolite.

November 1, 1991

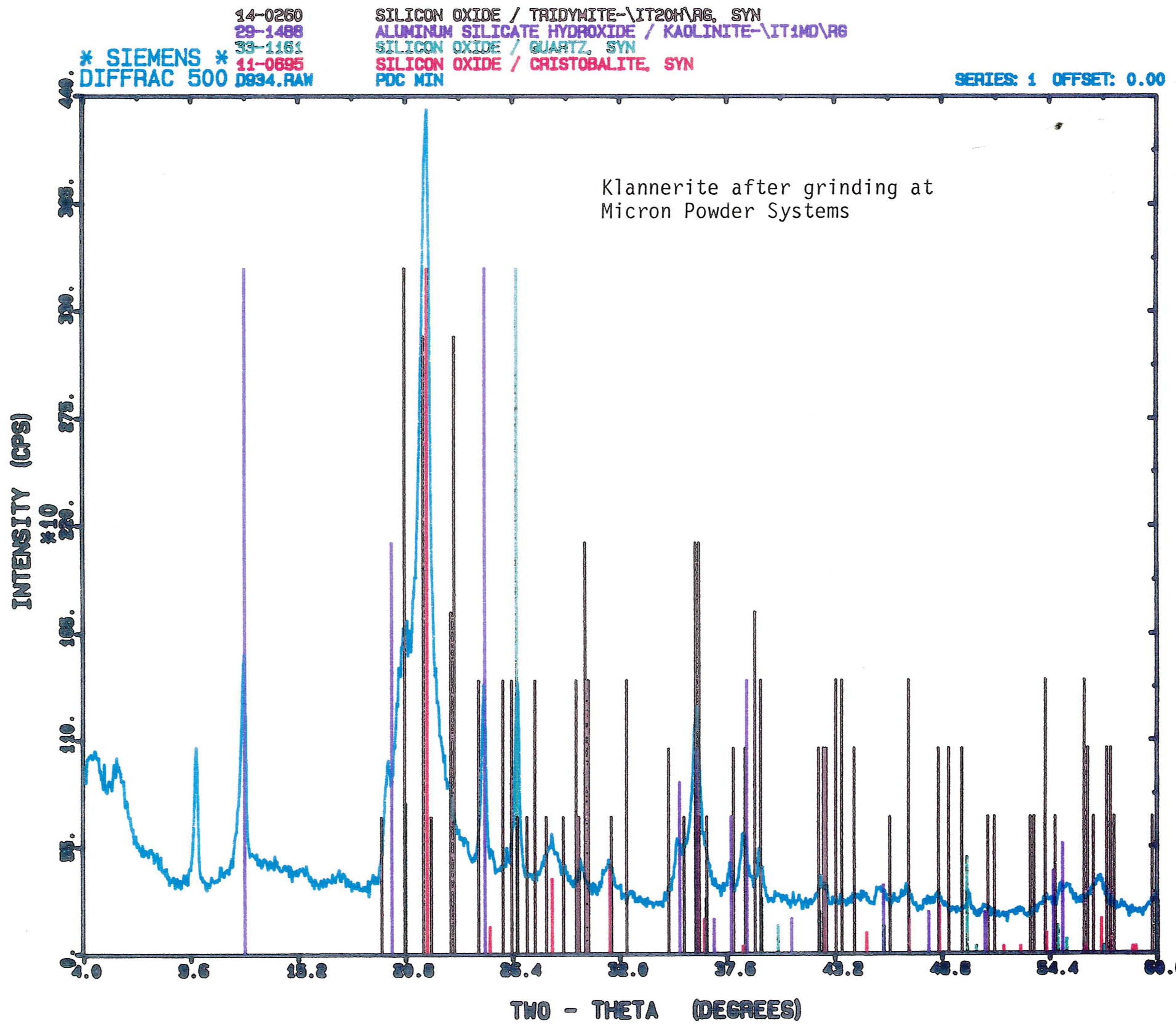


Figure 12. X-ray diffraction pattern of Klannerite after being ground at Micron Powder Systems. Vertical brown lines emanating from base line represent JCPDS pattern for Tridymite.

November 1, 1991

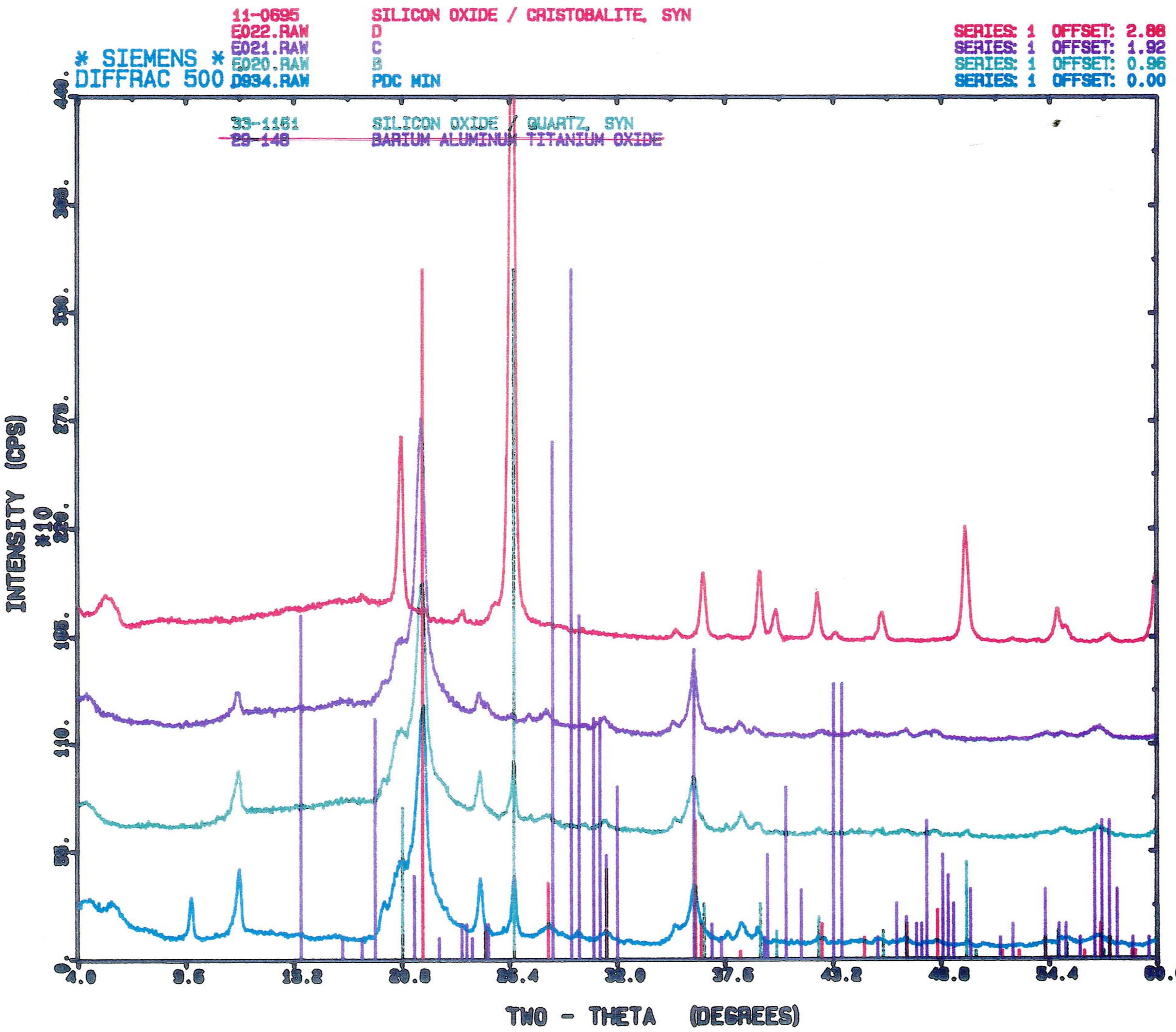


Figure 13. Summary of four Klannerite patterns.

November 1, 1991

MIKRO-ACM™ PULVERIZERS

SPECIFICATIONS

MODEL	MAIN DRIVE MOTOR	SEPARATOR DRIVE MOTOR	GRINDING ROTOR SPEED	SEPARATOR WHEEL SPEED	AIR CAPACITY	LOWEST AIR STATIC PRESSURE LOSS (approx.)	GRINDING CHAMBER	APPROX. SHIPPING WEIGHT WITH MOTORS & DRIVES	HEIGHT, WIDTH, LENGTH	FLOOR AREA
10 ACM	10hp 3600 RPM	1hp 1800 RPM	7000 RPM	625 to 4000 RPM	500 to 1000 CFM	12" H_2O	13" I.D.	1150 lbs.	43"H 24"W 44"L	8 sq. ft.
30 ACM	30hp 3600 RPM	5hp 1800 RPM	4600 RPM	500 to 2500 RPM	1500 to 2200 CFM	18" H_2O	19.5" I.D.	2500 lbs.	48"H 38"W 94"L	21 sq. ft.
50 ACM	40hp & 50hp	7.5hp 1800 RPM	4600 RPM	500 to 2500 RPM	1500 to 2200 CFM	18" to 21" H_2O	19.5" I.D.	3600 lbs.	84-1/2"H 33"W 65-1/2"L	25 sq. ft.
60 ACM	60, 75 or 100hp 1800 RPM	7.5 to 10hp 1800 RPM	3000 RPM	600 to 2000 RPM	3000 to 4500 CFM	22" H_2O	30" I.D.	5200 lbs.	77"H 37"W 74-3/4"L	33 sq. ft.
200 250 300 ACM	200 to 300hp 1800 RPM	25 to 50hp 1800 RPM	2000 RPM	500 to 1500 RPM	10,000 CFM & up	25" H_2O	46" I.D.	12,000 lbs.	75-7/8"H 48-1/4"W 127"L	50 sq. ft.
400 ACM	400hp	25 to 50hp 1800 RPM	1725 to 1755 RPM	500 to 2000 RPM	4000 to 13,500 CFM	10" to 25" H_2O	51" I.D.	18,000 lbs.	233-1/2"H 133"W 141-1/2"L	60 sq. ft.

CAPACITIES

MATERIAL	FINENESS	10 ACM LBS. PER HOUR	30 ACM LBS. PER HOUR	50 ACM LBS. PER HOUR	60 ACM LBS. PER HOUR	200, 250, 300 ACM TONS PER HOUR	400 ACM TONS PER HOUR
ACRYLICS	100%-200 mesh	300	900	1500	1800	3	6
	100%-325 mesh	100	300	500	600	1	2
ACTIVE ALUMINA	98%-325 mesh	450	1350	2250	2700	4.5	9
ALUMINUM HYDRATE	75%-325 mesh	900 to 1000	2700 to 3000	4500 to 5000	5400 to 6000	9 to 10	18 to 20
BARIUM STEARATE	86%-325 mesh	500	1500	2500	3000	5	10
CLAY	99%-325 mesh	700	2100	3500	4200	7	14
COAL	85%-200 mesh	300	900	1500	1800	3	6
COCOA	99%-200 mesh	700 to 800	2100 to 2400	3500 to 4000	4200 to 4800	7 to 8	14 to 16
COPPER OXIDE	99%-325 mesh	800	2400	4000	4800	8	16
CORN FLOWER	99%-325 mesh	250	750	1250	1500	2.5	5
DACTHAL	99%-325 mesh	833	2500	4100	5000	8.3	16
EPOXY POWDER	100%-200 mesh	400	1200	2000	2450	4	8
	100%-325 mesh	150	450	750	510	1.5	3
FISH FOOD	60%-325 mesh	190	570	950	1140	1.9	3.8
	75%-325 mesh	85	255	425	510	.85	1.7
GRAPHITE	98%-325 mesh	500	1500	2500	3000	5	10
KALOIN	100%-400 mesh	600	1800	3000	3600	6	12
LACTOSE	98%-325 mesh	300	900	1500	1800	3	6
LIMESTONE	83%-200 mesh	2000	6000	10,000	12,000	20	35
MAGNESIUM OXIDE	99%-325 mesh	500	1500	2500	3000	5	10
PHENOLIC RESIN	97%-200 mesh	700	2100	3500	4200	7	14
RICE (PAR BOILED)	70%-200 mesh	167	500	800	1000	1.6	3
SODIUM BICARBONATE	92%-325 mesh	900	2700	4500	5400	9	18
SODIUM CHLORIDE	65%-325 mesh	1200	3600	6000	7200	12	24
SODIUM PHOSPHATE	96%-200 mesh	600	1800	3000	3600	6	12
SOYA BEAN (FLAKE)	99%-200 mesh	300	900	1500	1800	3	6
SUGAR (COARSE)	98%-200 mesh 92%-325 mesh	900	2700	4500	6750	9	18
SUGAR (FINE)	99%-325 mesh	786	2358	3900	5895	7.86	15.6
TOBACCO SCRAP	99%-100 mesh	450	1350	2250	2700	4.5	9

Above are for reference only — testing is recommended.

MikroPul

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MIKRO-ACM™ PULVERIZERS

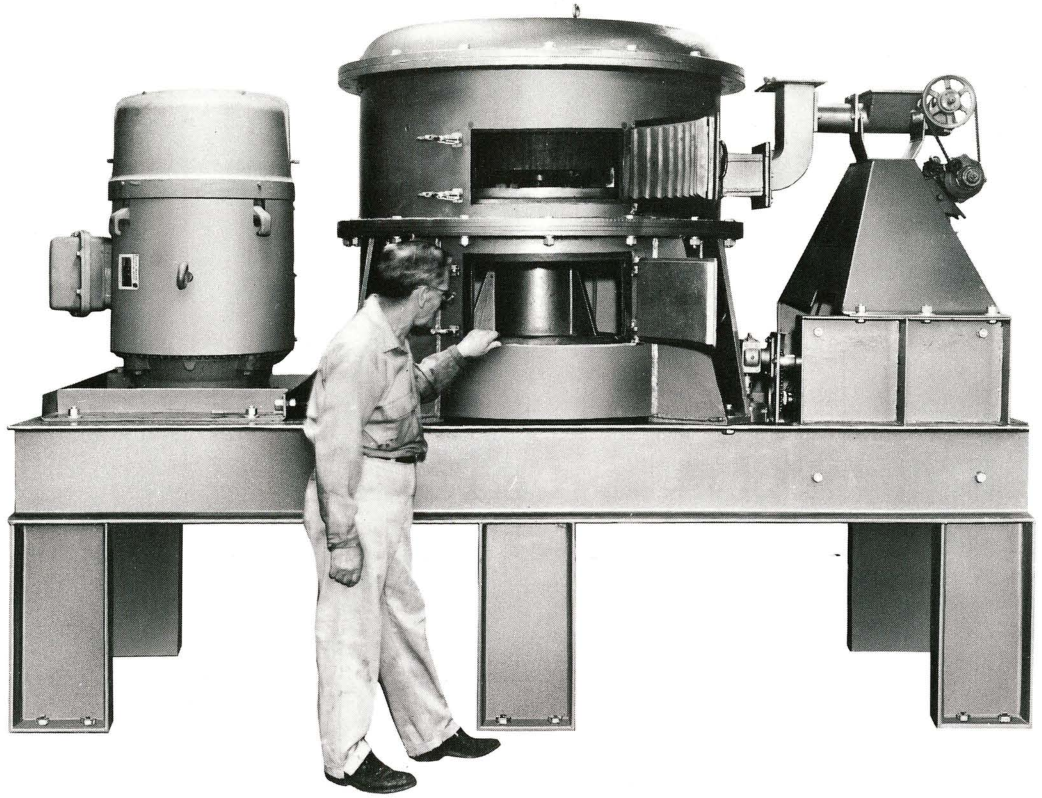
MikroPul

HOSOKAWA MICRON

HOSOKAWA MICRON INTERNATIONAL INC.

MIKRO-ACM™ PULVERIZERS

- For more efficient transportation of ground material from grinding rotor to separating element
- Oversize material rejected back to grinding rotor
- Eight models available for a wide range of requirements



The **Mikro-ACM™ Pulverizer** is a user-friendly and versatile component of a system which is comprised of the Air Classifier Mill (ACM), the Mikro-Pulsaire™ Product Collector with a Mikro-Airlock, and a fan. (See system diagram, facing page.)

The basic design of the Mikro-ACM is the most efficient on the market today for particle reduction of dry materials. Though often copied, it has never been successfully duplicated. If there could ever be a universal mill to meet every application, this is the closest to it.

It is important to note that there is only one rotor disc with impactors mounted securely to the disc, yet they are easily removable and considered replaceable.

This independently driven rotor with its lesser mass provides for lower usage horsepower, which affects the *cost of operation.*

The *ultra-efficient aerodynamic transport system* consistently sweeps the material directly in front of the hammers at right angles to the hammers. Competitive designs allow the material to *pick up the peripheral speed of the rotor*, which affects the impact energy transferred to the particle, again, affecting efficiency.

This vertical impact design incorporates an added feature worth noting: As the feed material is introduced into the grinding chamber, the movement of air from below the rotor disc sweeps the fines in the feed directly to the classifier. This pre-classification insures that work is only performed on that fraction of material which is larger than your requirements — again, enhancing efficiency.

The classifier, an integral component of the mill, allows acceptance of the desired particles. Those particles rejected by the classifier are continuously recycled back to the impactors for further reduction. The classifier design with its tapered blades has been proven by our research to produce a narrow particle distribution.

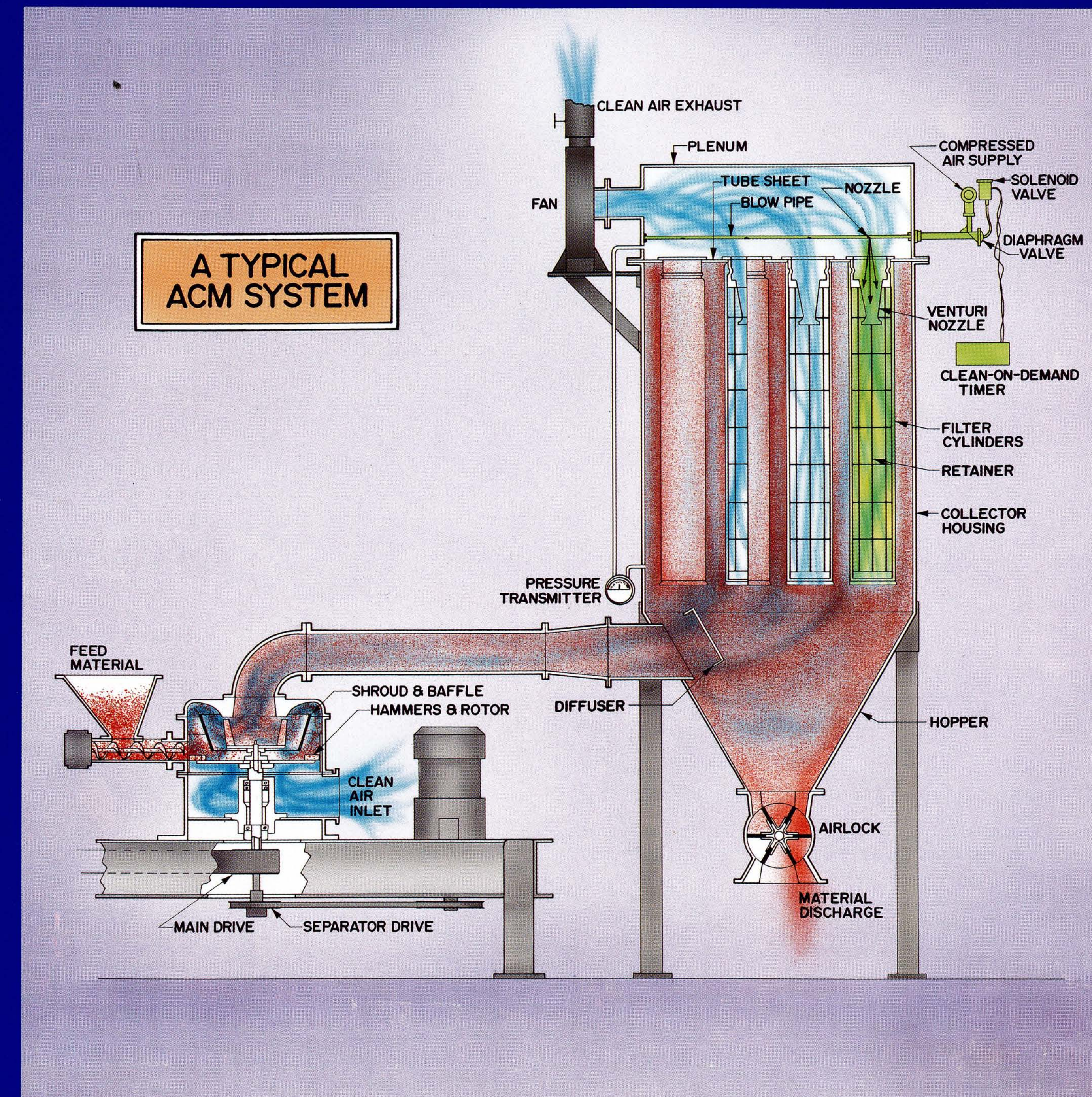
Built into the design is the capability to change the speed of the classifier over a wide range while the unit is in operation. This feature is necessary to compensate for rises in differential pressure losses across the product collector during initial start-up.

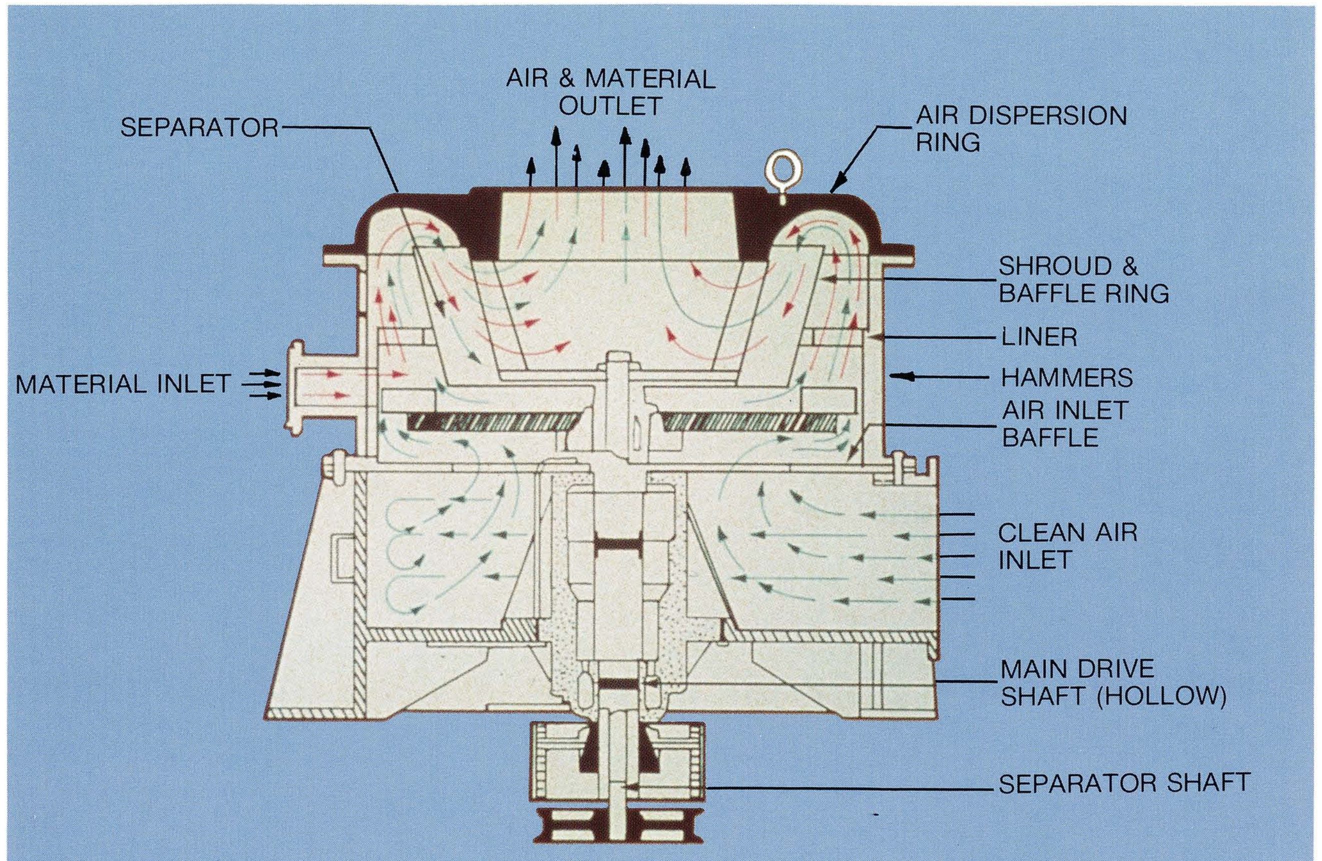
The capability to change the speed of the classifier allows for optimizing peak capacity. Once the system is stabilized, the Mikro-ACM will continue to produce the same fineness and capacity on a daily basis. Should future requirements change, this air classifier mill does not become obsolete. Just make the necessary changes to the classifier speed, and produce the required product.

It is not uncommon for one mill to produce different *grades* of material, such as different grades of sugar. Different *types* of materials can also be handled as well. In the powder coating field, for example, materials such as polyester, epoxy, teflon, acrylic and urethane are run through the same Mikro-ACM to meet production demands.

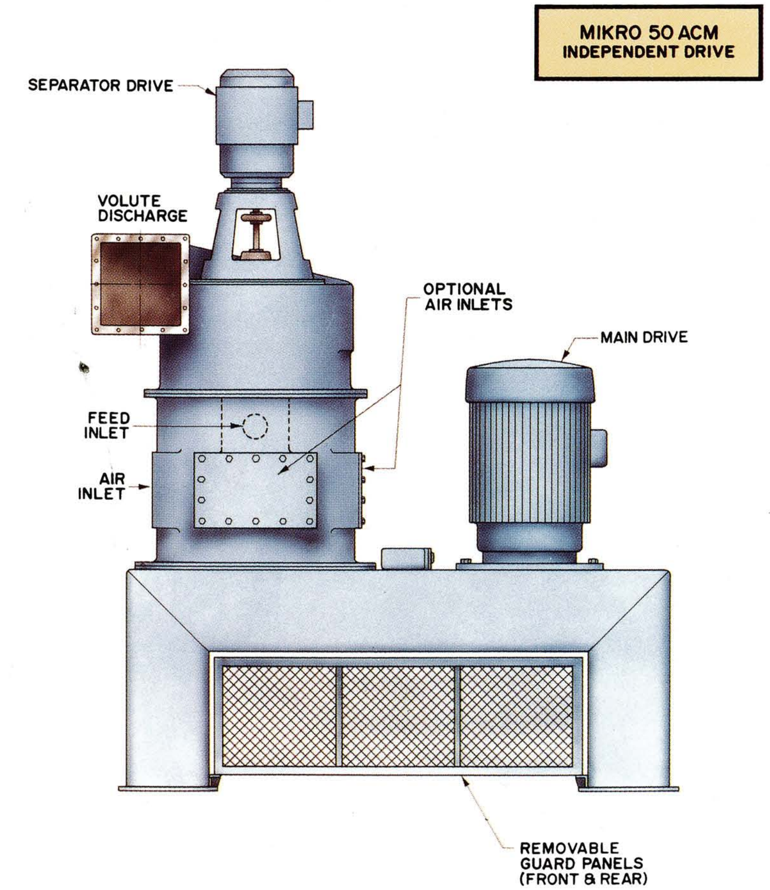
FEATURES

- Economical, efficient recovery of fine powders
- Particle size readily adjustable without shutdown
- Simple to clean, maintain and operate
- Low grinding temperature

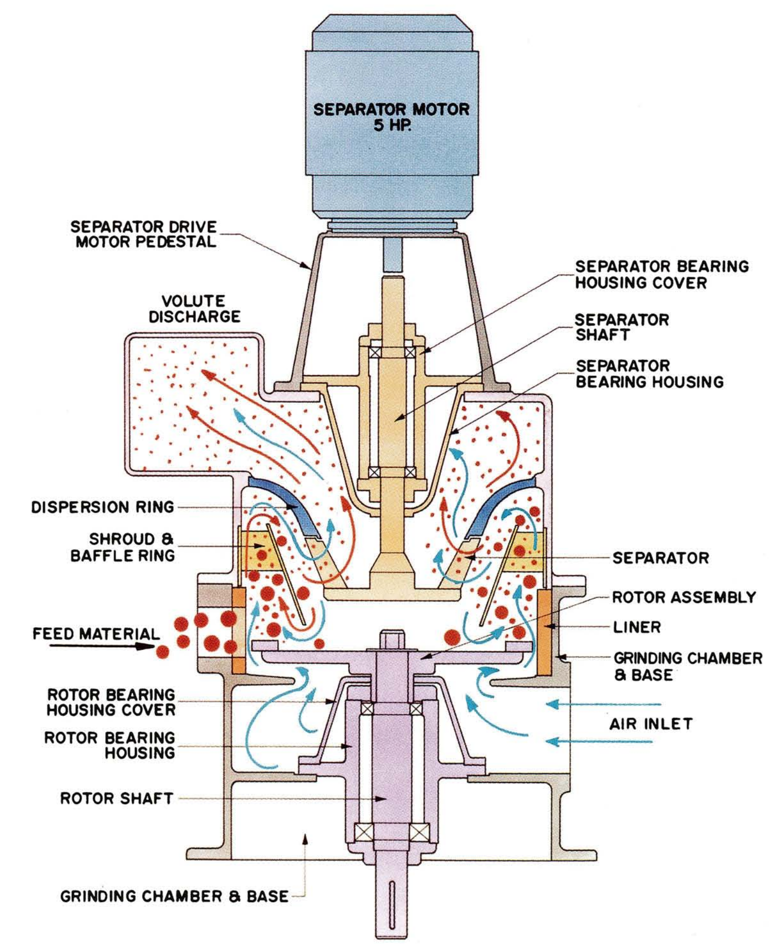




Sectional of MIKRO ACM PULVERIZER, illustrating air and material flow.



The illustration on the left is a general view of the grinding chamber mounted on the structural base with motors.



Cross sectional view of the 50 ACM Pulverizer, showing air and material flow.

Principle of Operation

The material to be ground is conveyed from the hopper by means of motor-driven mechanism to a pin or bar rotor where break-up of material occurs. As particles decrease in size, they are entrained by the air wall and shroud ring with baffles. The particles are then deflected inward by an air dispersing ring to be either accepted or rejected by the separator).

Acceptable ground particles are drawn upward through the exhaust and to the collector. Oversize particles are carried downward by the internal airstream and returned to pin or bar rotor for additional grinding.

All Mikro-ACM Pulverizer units incorporate significant design improvements. The 200, 250, 300 and 400 ACM models have a push-button separator speed control for automatic particle size control. It has inspection doors in both the grinding chamber and main bearing house. Automatic continuous oil lubrication of the main shaft bearings is standard on Models 200 and 400.

Cool Grinding

Efficient reduction of heat-sensitive material: Constant flow of air passing through the Mikro-ACM Pulverizer maintains a reasonable low temperature, making it ideal for handling most heat sensitive materials. The unit will handle a wide variety of such materials without the aid of coolants.

Economical Operation

Lowered power consumption is realized by the efficiency of material transportation, resulting in low operating costs for comparable fineness.

Genuine Replacement Parts

Genuine MikroPul Hosokawa Micron Replacement Parts are manufactured to the highest precision standards to assure continued high efficiency performance of all MikroPul Hosokawa Micron equipment.

Mikro-ACM Pulverizer Sizes

The Mikro-ACM Pulverizer is presently available in various sizes: Model 10, Model 30, Model 50, Model 60, Model 200, Model 250,* Model 300,* Model 400. In their principle of operation as well as performance they are identical, with relative capacity being the only difference. (Please see specifications chart on back cover for various ACM sizes and other data.)

*Models 250 and 300 are same dimensions as Model 200, but differ only in motor sizes.