BEARCAT
explorations ltd.

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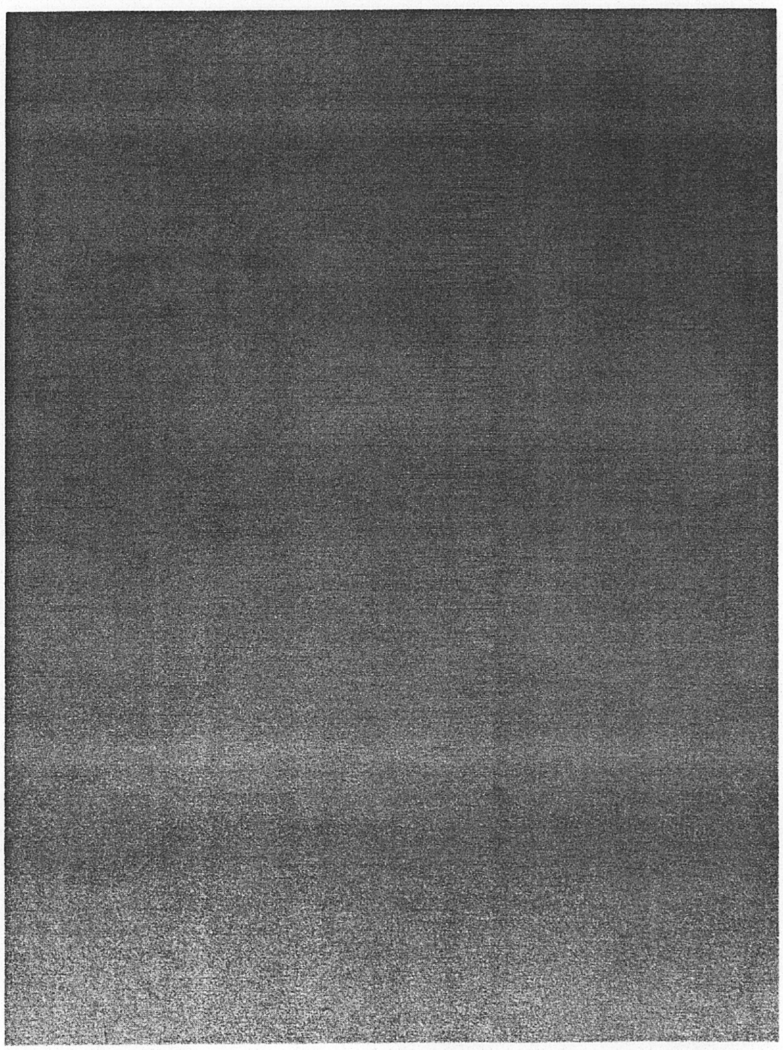

Annual Report 1985

Report To Shareho[ ]ers

The delay in mailing the Annual Report for 1985 to the Shareholders has been mainly as a result of a requirement set by the new auditors for Bearcat Explorations (U.K.) Limited, Bearcat's 51.2% U.K. subsidiary. The Bearcat Explorations (U.K.) Limited management located in Edinburgh, Scotland was terminated August 31, 1985 and new interim management was subsequently established in London. This change in management involved new London-based auditors and has necessitated, at their direction, review examination procedures on the records of Bearcat Explorations (U.K.) Limited from the date of its incorporation in 1978.

The year ending November 30, 1985 for the Canadian oil and gas industry was generally one of regrouping and partial recovery from the effects of the Federal N.E.P. policies. As this report is being prepared though, the current industry economic environment makes reflections of the N.E.P. era appear in an almost nostalgic light. Bearcat, as a direct result of several past transactions finds itself in a stable position and does not anticipate any difficulties in withstanding the current world oil price problem.

Reduced revenues in 1985 kept the Company's exploration endeavours in Canada to a minimum. Four wells were participated in directly, of which three were dry holes and the fourth completed as an oilwell. The Company also negotiated an agreement where, with partners, it paid for the completion and hook-up of an already existing Viking gas well, to earn an undivided 17.9% interest in the well. This well commenced production in July, 1985.

A number of exploratory wells were drilled on Production Licences on which Bearcat Explorations (U.K.) Limited holds GOR's (gross overriding royalties), during the past year. Twelve new development wells have now been drilled and completed in the Humbly Grove oil field located on PL 116(b) and one in the developing Malton gas field on PL 0?0(a), both fields on which Bearcat Explorations (U.K.) Limited holds GOR's. The Humbly Grove field will commence production in early 1986 from a total of 16 wells. Malton now has a total of four wells completed in the main gas zone and, in preparation for production, the drilling of four more wells is expected in the immediate future.

A significant new major oil zone was discovered in a lower Triassic horizon in the Humbly Grove field in early 1986. This new pool, which tested approximately 1,465 BBLS. of 48° gravity oil per day at a stabilized rate, is indicated to be a very significant discovery.

Mining exploration and development activities by the Company's 100% subsidiary, Lumberton Mines Limited, has been very encouraging. The Company is participating in two new areas of mining exploration interest, a heap leach gold prospect in southeastern California and a platinum prospect in the north Creston area of southeastern British Columbia. The Company still retains its interests in the Siwash Creek claims near Hope, British Columbia, where a nearby gold mine is reportedly being readied for a resumption of production.

Exploration and development work has progressed on the Hellroaring Creek feldspar/beryllium prospect in the west Kimberley area of southeastern British Columbia. A late start on the planned drilling program coupled with another early winter in this area in 1985, restricted the program to a total of 1,883 ft. of coring in eight holes. Sufficient proven tonnage has been developed to initiate a pre-feasibility study which is currently underway. Indicated additional probable tonnage as a result of this program is substantial. It is anticipated that this property can be ready for the commencement of production by fall of 1986 or the early summer of 1987, at the latest. The available market and corresponding production potential is considerable.

As part of an Agreement entered into August 13, 1984, with the shareholders of Landbank Minerals Ltd., Bearcat made an acquisition offer for the oil and gas interests of the Landbank Resources 79-80 and 1980 Programs. Revenue from these two programs was not meaningful from a single unitholder's point of view, but the total revenue amount is significant to the Company and even more so now as it is mainly derived from natural gas production rather than oil. The Company has acquired varying interests in 17 oil wells and 63 gas wells with these two transactions. These new interests in approximately 103,780 gross acres of oil and gas leases are expected to avail to the Company additional opportunities for developing new and increasing reserves. A total of 1,788,951 common voting shares of Bearcat were issued as consideration for these interests.

Part of an August, 1984 Agreement provided for Bearcat to acquire a 40% share position in Landbank Minerals Ltd. Direction by Bearcat's management designee for Landbank Minerals Ltd. enabled the General and Administrative for Landbank to be reduced from $1.5 million/year to $750,000/year during the ensuing year and increased the net revenue of Landbank by approximately $420,000/year. Despite this initial operation improvement, The Royal Bank of Canada, which holds an approximate $18 million debenture from October, 1983, placed Landbank Minerals Ltd. into receivership on September 24, 1985. The write-off of this non-cash investment this year reflects only a reduction in book value.

Bearcat, during an eight-month period beginning in July of 1984 to February, 1985 initiated, voluntarily, a reduction of its outstanding bank indebtedness from $6.2 million to approximately $1.97 million, a decrease of 68%. The Royal Bank, the Company's banking connection at the time, responded to this example of fiscal responsibility by refusing to even consider accommodating the Company in its efforts to restructure its remaining debt. Bearcat terminated its connection with The Royal Bank of Canada as of November 30, 1985.

Subsequent to this, in March of 1986, the Company has been forced to initiate litigation against The Royal Bank for applying oil and gas revenues generated from the interests of Landbank Resources 79-80 and 1980 Programs against the debts of Landbank Resources Ltd. and Landbank Minerals Ltd., the rights to most of which have been acquired by Bearcat from the Landbank Resources 79-80 and 1980 Programs. This action claims for diverted revenues in the approximate amount of $750,000.00, as well as funds presently held by the Receiver of Landbank Minerals Ltd. in the amount of $136,168.00, and damages of $500,000.00. Part of this action also included a court restraining order related to a joint venture trust account of Landbank Minerals Ltd., in which approximately $75,000.00 of Bearcat's revenues from the new oil and gas interests have been held up prior to September 23, 1985. The restraining order will ensure that revenue belonging to the Company, will be recoverable, rather than it as well being applied to the indebtedness of Landbank Minerals Ltd. and Landbank Resources Ltd. as had been the intention of The Royal Bank.

Though the Company's gross oil and gas revenue is less than 50% of that for the comparative year ending November 30, 1984, the earlier figure incorporates revenues from the Caroline and Medicine River oil production which were sold, at a top world oil price equivalent, to help facilitate the Company's debt reduction. Not included in this year's revenue tabulation is oil and gas revenue related to the Bearcat oil and gas interests formerly held by the two Landbank Resources Programs, which have been diverted and applied against loans of Landbank Minerals Ltd. and Landbank Resources Ltd. by The Royal Bank, and the previously mentioned trust account revenues, in all totalling approximately $590,000.00 with accrued interest from September, 1985. As stated earlier in the text of this report, these revenues are now subject to litigation initiated by the Company against The Royal Bank.

Oil and gas revenues related to the former Programs' interests and generated subsequent to the Landbank Minerals Ltd. receivership action, are now being received by Bearcat and essentially have brought the Company's revenue back up to the November 30, 1984 level.

A loss of 0.72¢ per share is reflected in the year end financial statements mainly as a direct result of extraordinary write-offs in Bearcat Explorations Inc., Bearcat Explorations (U.K.) Limited and Landbank Minerals Ltd. These write-offs relate to accrued expenses incurred by the Company's subsidiaries in the U.S. and the U.K. beginning in 1979.

At the instigation of the Defendants, the Stolberg Pipeline tariff litigation was settled out of court last year to the satisfaction of Bearcat. Tariff revenue is now being realized from this forty-mile 16-inch sour gas transmission line.

The Company has recently entered into a Settlement Agreement with Home Petroleum Corporation of Houston, Texas relative to litigation commenced in 1982. Although Bearcat's solicitors were confident that the Company had a strong justifiable defence, in order to avoid the uncertainty, time and expense of continuing litigation, the Company elected, on advice of its counsel, to respond to an overture from Home Petroleum Corporation (U.S.) and negotiated a settlement. This settlement provides for a payment by Bearcat to Home Petroleum Corporation of $100,000 (Cdn.) and four payments of $75,000 (Cdn.) over the next two years, in intervals of six months. As part of the consideration for settlement, Home Petroleum Corporation, a controlled subsidiary of Hiram Walker Resources Ltd., will acquire a 500,000 share position in Bearcat. This share block is subject to a one-year share sale restriction required under Alberta Securities legislation, and in addition Home has agreed not to dispose of any more than 25% of its holdings in any one subsequent year.

The settlement was reached in an amicable manner and the Company feels that the involvement of Home as a significant shareholder in Bearcat is a positive development. Had the litigation continued to trial, Bearcat could have been exposed to a possible $5,400,000 (Cdn.) judgement, whereas the $400,000 (Cdn.) payment over two years, without interest, discounted today represents approximately 6% of the possible judgement amount.

The current world wide lack in stability related to oil prices is imparting a severe negative impact on the exploration industry in Canada, with the small and medium-sized companies being hit the hardest. Prior transactions by Bearcat placed it in a relatively strong position with regards to weathering this dilemma.

The Company's major bank debt reduction in late 1984 and early 1985, entailed in part, the sale of a major part of its then existing oil production at a very favourable oil price. Acquisition of the two Landbank Resources Programs has effectively doubled the Company's net revenue, with most of the new revenue source being gas production. Terminating the Company's association with The Royal Bank of Canada and arranging for a more accommodating banking connection was also very timely. These transactions, plus the Company's relatively low overhead policy has enabled it to avoid the dire financial straits now being experienced by other companies.

GOR revenues from the Humbly Grove oil field production in the U.K. will be forthcoming in June of this year and will further contribute to the continuing stability of the Company. These revenues are expected to commence at the rate of a minimum of $125,000.00 per year in 1986 (at $10.00 U.S./BBL) and increase to approximately $250,000.00 per year in 1987 and at a rate of approximately $1,000,000.00 per year thereafter. A very significant deeper oil discovery in the Humbly Grove field is expected to at least double and probably triple this revenue projection, possibly by as early as 1987.

The Hatfield Moors gas field commenced production in the latter part of 1985 and is expected to escalate substantially. Gas production from the Malton field is expected to commence at very significant rates in late 1987. The GOR revenues from both of these fields will also contribute considerably to the growth of Bearcat.

During the past fiscal year, the Company has continued its policy to diversify its revenue base. The main current prospect is the Hellroaring Creek feldspar/beryllium project which could be on production in late 1986. Bearcat holds a 55% interest in this property. A limited market survey conducted early this year indicates a very significant existing market in the western U.S. and Canada, and also suggests that Hellroaring Creek, as a major regional source of these commodities, should encourage and influence a further on-going development of western markets. Net revenues to Bearcat are expected to be very substantial and should vary from approximately $1 million in 1987 to $7 million in 1990.

The Hellroaring Creek products are not subject to the current depressed mining commodity prices as related commercial mineable deposits are scarce. The main supplier of nepheline syenite (feldspar substitute) for Western Canada is located in Ontario, while the major source of feldspar for the western U.S. is in North Carolina, on the eastern seaboard. The high expense of rail hauling from both of these sources to the western markets will be eliminated in the price of the Hellroaring Creek product.

The period for converting the outstanding Bearcat Warrants has been extended to October 31, 1986. The price for conversion of these Warrants into Bearcat common voting shares is $1.75 per share.

Although the current Canadian oil and gas scene appears somewhat bleak, Bearcat's status is relatively strong and its financial position can be expected to strengthen considerably.

The Company's oil reserves have diminished over those of the past year, but this is more than compensated for by the very significant increase in recoverable proven and probable gas reserves, from 9.4 BCF to 16.9 BCF. The translation of the Company's efforts to diversify to significant alternative sources of revenue is near to being realized with the advent of production at Hellroaring Creek. New revenues from this sector, along with the newly generated GOR revenues through Bearcat Explorations (U.K.) Limited, coupled with an expected strengthening of the world oil price towards the end of 1986 will all contribute to the Company's on-going stability.

Until such time as the world oil price stabilizes at a more realistic price, Company policy will be one of caution with regards to normal oil and gas industry exploration. It will be prepared, however, to participate in prospects that are of extraordinary reserve developing potential and which have relatively low exploration costs.

The financial and exploration prospects for Bearcat in the coming year are viewed with optimism.

On Behalf of the Board of Directors

J. W. McLeod
President

Calgary, Alberta
April 19, 1986

VI Mining Operations

HELLROARING CREEK PROSPECT, KIMBERLEY AREA, BRITISH COLUMBIA FELDSPAR, MICA, SILICA AND BERYL

Bearcat Explorations Ltd. is continuing to pursue a policy aimed at developing alternative revenue sources apart from the oil and gas industry. The results of the exploration and development work conducted on the Hellroaring Creek feldspar prospect in southeastern British Columbia, and the subsequent probable commencement of production from the prospect in the fall of this year is considered to be a significant step in this direction. Results of flotation tests on bulk samples from the property, as well as subsequent related analyses, are substantive of ore-quality material. A pre-feasibility study is to be prepared during April and May, 1986, by the engineering firm of Dolmage Campbell & Associates (1975) Ltd. of Vancouver. It is hoped that a mill can be in place and possibly in production by late fall of this year.

The Company's share of projected net annual revenue from this prospect is expected to be in excess of $1 million in 1987 and possibly as high as $7 million in 1990. A long term projection demonstrates a very positive net revenue escalation pertaining to all related products.

GREENWATER VALLEY PROSPECT, SHOSHONE AREA, SOUTHERN CALIFORNIA HEAP LEACH GOLD

The Company has a 16.66% undivided interest in 22 contiguous patented claims staked on a mineralized trend which extends for a distance of approximately six miles. This prospect has several known gold and silver shows on it and is located very favourably with respect to the possible development of this type of gold deposit.

The results of preliminary exploration work in early 1986 has encountered encouraging mineralization. This initial work program has endorsed the necessity of conducting a second stage program to include additional surface mapping and diamond drilling, in late spring of 1986.

RAM PROSPECT, CRESTON AREA, SOUTHEASTERN BRITISH COLUMBIA PLATINUM, PALLADIUM

The Company has a 55% undivided interest in an approximate 1,000 acre, 18-unit claim block 1.8 miles in length by nine-tenths of a mile in width. An exploration program will be conducted in 1986 to evaluate laterally, from an old showing which is reported to have appreciable values of platinum, palladium and some gold-bearing sulphides disseminated through a zone approximately 40-50 ft. in thickness. The program will attempt to establish length and width to this zone, as well as determine grade. The geological setting of the original mineral show suggests a strong possibility of extensive lateral development and continuity.

Like the Hellroaring Creek prospect, Ram is very readily accessible. The current escalation in the price of platinum, related to the long term weak supply and strong demand situation, makes this prospect very attractive. Both platinum and palladium are essential in the space and high-tech industries.

Corporate Data

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SHARES LISTED	The Alberta Stock Exchange

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FELDSPAR

A Chapter from
Mineral Facts and Problems,
1985 Edition

UNITED STATES DEPARTMENT OF THE INTERIOR

FELDSPAR

By Michael J. Potter[1]

Feldspar is the general name given to the members of a group of closely related minerals that are essentially anhydrous aluminum silicates in combination with varying proportions of one or more bases, one of which usually predominates and characterizes the particular type of material. Potash feldspar, soda feldspar, and lime feldspar are the varieties most commonly distinguished. Feldspars are major components in most igneous rocks and constitute a large part of at least the outer layers of Earth and its Moon. Feldspar is thus one of the most abundant materials in the world, and a large supply is available.

As a major producer of feldspar, the United States is self-sufficient in this commodity; imports are almost nonexistent, and exports are about 1% of production. U.S. feldspar production in 1983 was 710,000 short tons[2] with a value of $22.5 million. The mineral was mined in six States, led by North Carolina and followed, in descending order, by Connecticut, Georgia, California, Oklahoma, and South Dakota. North Carolina accounted for 72% of the total.

Feldspar, usually of the potash or soda type or in mixtures of the two, finds its principal end uses in the manufacture of glass and ceramics; in both applications it acts as a flux. In glassmaking, feldspar also provides a source of alumina, the presence of which enhances the workability of the product, inhibits any tendency toward its devitrification, and increases its chemical stability. Glass containers, the largest outlet for feldspar, have been facing stiff competition from plastic bottles and metal cans. Other major end uses for feldspar are in sanitary ware, glass fiber, and tile, which are related to the building industry. A new market area for feldspar products may be as a filler in paint, rubber, and plastics.

Reserve data are generally not available, but U.S. reserves were estimated to be at least 200 million tons in the Spruce Pine district of North Carolina alone.

U.S. demand for feldspar in the year 2000 is forecast to reach 800,000 tons. The forecast range is 730,000 to 960,000 tons. The percentage rate of increase of long-range demand for feldspar in the rest of the world is expected to be somewhat higher than that of the United States. The forecast range of demand for the rest of the world in 2000 is 3.7 to 4 million tons, with the probable tonnage placed at 3.8 million tons.

INDUSTRY STRUCTURE

Background

Mining of feldspar in North America is evidently older than the United States. Examination of shards from a large number of prehistoric culture centers, widely distributed in both place and time, shows that the aboriginal potters often depended upon feldspar or feldspathic sand, added intentionally or not, to provide the temper for the clays from which they formed their vessels. A smal quantity of the mineral, reputedly obtained from the natives, is said to have been shipped to Europe in 1744 from somewhere in the mountainous western part of what is now the State of North Carolina, the same area that was to become, two centuries later, the primary focus of the Nation's feldspar industry.

No significant shipments from the Carolina region were reported until about 1911, however, and the feldspar industry of the United States is considered to date more properly from the start of commercial production from Connecticut pegmatites around 1825. For many years afterward, feldspar from this source was hand-sorted, packed into barrels, and shipped across the Atlantic for use in the potteries of the United Kingdom. About 1850, a mill was constructed near Middletown, CT, to grind feldspar from nearby mines to supply the pottery industry that was beginning to develop in America and so reduce dependence upon the feldspathic material known as Cornwall stone, then being imported from the United Kingdom for the same purpose.

Connecticut continued to lead all other States in feldspar production until 1909. North Carolina has been the leading U.S. State in feldspar production since World War I.

Traditionally and until comparatively recent times, feldspar was produced commercially only from especially favorable deposits of the zoned pegmatite type that could yield block material suitable for selection by hand and eye to provide the needed fluxing action in ceramic body mixes. That long-established pattern underwent a radical change in the present century because of two consecutive technologic developments, each of which in turn had the effect of tilting the trend line for domestic feldspar production sharply upward.

The first of these stimuli, dating from about 1900, resulted from a series of discoveries pointing out the advantages of adding feldspar to glass-furnace feed for the purpose of bringing alumina and supplemental alkalies into the melt. Subsequently, alumina-bearing glass was found to be especially favorable for automated-machine fabrication of glass bottles, and the accelerating demand for that type of container soon caused glassmaking to become the foremost end use for feldspar in the United States.

The second major impetus, reinforcing the first, was the achievement around 1940 of successful froth flotation methods for the beneficiation of feldspar. That innovation provided a practical means of separating feldspar from mica, quartz, and some iron minerals with which it is often associated. Thus, flotation notably extended the roster of workable deposits, freeing the industry from its reliance on sources amenable to exploitation only by older and more costly hand-cobbing procedures. At the same time, flotation offered a substantial reduction in cost per ton, and made large-scale production of feldspar an economic reality.

Size and Organization

The largest producers and processors of feldspar in the United States in 1983 included the Feldspar Corp., with operations in Connecticut, Georgia, and North Carolina, and Indusmin Inc. and International Minerals & Chemical Corp. in North Carolina. Other producers were Calspar Inc. in California and Pacer Corp. in South Dakota. Feldspar or feldspar-silica mixtures were produced as a coproduct by Foote Mineral Co. and Kings Mountain Mica Co. Inc. in North Carolina and Spartan Minerals Corp. in South Carolina. Output of feldspar-silica sand came from Crystal Silica Co. and Owens-Illinois Inc. in California and Arkhola Sand and Gravel in Oklahoma.

[1]Physical scientist, Division of Industrial Minerals.
[2]The quantities used throughout this chapter are short tons unless otherwise specified.

Table 1.—World feldspar production, 1983, and capacity, 1983, 1984, and 1990
(Thousand short tons)

	Production	Capacity		
	1983e	1983e	1984e	1990[1]
North America:				
Guatemala	11	30	30	30
Mexico	120	150	150	180
United States	710	920	920	920
Total	841	1,100	1,100	1,130
South America:				
Brazil	146	150	150	160
Other	91	100	100	120
Total	237	250	250	280
Europe:				
Finland	77	90	90	100
France	190	220	220	240
Germany, Federal Republic of	370	400	400	430
Italy	880	900	900	900
Norway	80	100	100	110
Poland	88	100	100	120
Romania	65	70	70	80
Spain	135	150	150	180
U.S.S.R.	360	380	380	440
Other	149	160	160	160
Total	2,394	2,570	2,570	2,760
Africa	64	80	80	100
Asia and Oceania:				
India	47	60	60	70
Korea, Republic of	94	100	100	110
Turkey	80	100	100	100
Other	121	140	140	150
Total	342	400	400	430
World total	3,878	4,400	4,400	4,700

eEstimated.
[1]Forecast.

In general, feldspar mine capacity is about double that for milling, or product, capacity. Overall mine-mill capacity is usually limited by milling capacity and existing trucking and crushing-plant facilities.

U.S. feldspar was mined in six States in 1983, led by North Carolina and followed in descending order by Connecticut, Georgia, California, Oklahoma, and South Dakota. North Carolina accounted for 72% of the total.

Eleven U.S. companies operating 16 mines and 12 plants produced feldspar or feldspar-silica mixtures for shipment to more than 31 States and foreign countries, primarily Canada and Mexico. Three of the eleven companies produced potash feldspar, and the remaining companies produced mixed feldspar or feldspathic sand mixtures. North Carolina had five plants, California had three, and Connecticut, Georgia, South Carolina, and South Dakota each had one.

World feldspar production in 1983 took place in more than 40 countries, among which the Federal Republic of Germany, Italy, the U.S.S.R., and the United States contributed about 60% of the world total.

Definitions, Grades, Specifications

Feldspar is the general term used to designate a group of closely related minerals, especially abundant in igneous rocks and consisting essentially of aluminum silicates in combination with varying proportions of potassium, sodium, and calcium. The principal feldspar types are orthoclase or microcline, both $K_2O \cdot Al_2O_3 \cdot 6SiO_2$, and anorthite, $CaO \cdot Al_2O_3 \cdot 2SiO_2$. Specimens of feldspar closely approaching these ideal compositions are seldom encountered in nature, however, and nearly all potash feldspars contain significant proportions of soda feldspar. Albite, or soda feldspar, and anorthite are the theoretical end members of a continuous compositional series known as the plagioclase feldspars, none of which are ordinarily without at least a minor admixture of potash. Commercially speaking, "potash spar" is feldspar containing 10% or more K_2O; "soda spar" contains 7% or more Na_2O.

Anorthite and the plagioclase feldspars are of limited commercial importance, and formerly, only the high-potash feldspars were regarded as desirable for most industrial purposes. At present, however, the potash and soda varieties, and mixtures of the two, are considered to be about equally acceptable in many applications. Perthite is the name given to material consisting of orthoclase or microcline and containing crystals that are intergrown with crystals of albite. Most of the feldspar of commerce can be classified most correctly as perthite.

Alaskite is a relatively coarse-grained, granite-like feldspar ore that occurs in the Spruce Pine district of North Carolina. The principal mineral ingredients of this ore are approximately plagioclase, 45%; quartz, 25%; microcline, 20%; and muscovite mica, 10%. Minor amounts of other minerals are also present (*7*).[3] Beneficiated feldspar from alaskite comprises a major portion of total U.S. feldspar output.

Feldspar for glass manufacturing, ordinarily ground to 20 to 40 mesh, with specified limits on overgrind, usually contains 4% to 6% K_2O, 5% to 7% Na_2O, and approximately 19% Al_2O_3. Material for this purpose may be sold as a feldspar concentrate low in free quartz or else in the form of a purified mixture containing feldspar and quartz with harmful impurities removed. In "glass-grade" feldspar, the iron content, expressed as Fe_2O_3, should not exceed 0.05% for high-quality clear glass or 0.3% for even heavily colored glass. Typically, 150 to 200 pounds of ground feldspar is used to produce 1 ton of container glass.

Feldspar with a high potash-to-soda ratio is often preferred for pottery making, and spar for this purpose is usually ground to minus 200 mesh. Potash spar ground to 120 or 140 mesh is usually specified for use in porcelain enamel, and even traces of such impurities as garnet, hornblende, tourmaline, and biotite mica ordinarily are not tolerated. Both potash and soda feldspars, ground to minus 200 mesh, are used in glazing.

Enamel feldspar, with similar specifications as to analysis as glass-grade feldspar, differs chiefly from glass grade in being much more finely ground. "Pottery-grade" feldspar for whiteware and similar ceramic products may range from 5% to 14% in K_2O content and usually is ground to 200 mesh or finer. Limitations on iron content may be even more stringent that for glass grade; sometimes not over 0.025% Fe_2O_3 is allowed. Feldspar for use in filler applications, such as for foam rubber products, may be similar to "pottery spar" in fineness of grind and chemical composition, although more free quartz is often accepted, and sometimes material for this purpose may be held to particle-size specifications expressed in micrometers.

RESERVES-RESOURCES

United States and World

Feldspar, one of the most abundant minerals in the Earth's crust, is found in significant amounts in some sedimentary strata and in nearly all igneous formations. Workable deposits of feldspar are probably widely distributed throughout most of the world, and the total quantity of the mineral potentially available is very large.

Feldspar has been estimated to constitute 60% of all crystalline

[3]Italicized numbers in parentheses refer to items in the list of references at the end of this chapter.

igneous rocks. Granted sufficient demand and economic incentive, the mineral could be extracted from the world's granite, a source that is extremely large.

Data are not available on the quantity of feldspar in either domestic or foreign deposits suitable for present or eventual exploitation, nor have the measurements been made that would be required to justify such a statement of reserves. However, U.S. reserves were estimated to be at least 200 million tons in the Spruce Pine district of North Carolina alone (*1*).

Geology

Feldspar concentrations of potential economic interest exist as prominent features of many zoned or unzoned pegmatites, granites, and other granitic rocks, and as accumulations of certain residual sands that have been sorted by moving water and deposited on ocean beaches or river banks.

Pegmatites are masses of coarsely crystalline rocks of igneous origin that occur as tabular or lenticular dikes. They are commonly associated with large, intrusive bodies of finer grained rocks, also igneous, that penetrate metamorphic terrains. Pegmatite bodies may range in size from small pods, stringers, or veins to extensive formations measuring hundreds or even thousands of feet.

The commercially important feldspar minerals present in pegmatites are orthoclase or microcline, or potash spar; albite, or soda spar; perthite, or potash-soda spar; and those of the plagioclase series, or soda-lime spar, sometimes further distinguished, according to decreasing soda and increasing lime content, as oligoclase, andesine, labradorite, bytownite, and anorthite. Other mineral species usually or occasionally found in pegmatites include quartz, muscovite mica, beryl, spodumene, and a large number of less common substances, a few of which may be recoverable in feldspar operations as byproducts or coproducts. Minerals likely to exist in pegmatites and usually considered to be objectionable impurities in the feldspar produced from those sources include biotite mica, pyrite, magnetite, chromite, garnet, ilmenite, tourmaline, rhodonite, and rhodochrosite.

The principal feldspar ore bodies of pegmatitic type currently being exploited in the United States are located in Connecticut, North Carolina, Georgia, and South Dakota. Potentially exploitable pegmatite bodies are known to exist in other areas.

In many cases, the chemical and mechanical forces of weathering may act upon exposed feldspar-containing formations, especially those of the granitic and pegmatitic varieties, in such a way as to produce bodies of residual fragments in situ that, although not greatly different from the original mass in gross composition, retain little or no coherence. The subsequent erosion of such fragmental accumulations, assisted by the natural processes of hydraulic winnowing, scouring, and differential transportation, can bring about a classification of the particles according to their respective sizes, shapes, hardnesses, and densities. Under favorable circumstances, this detrital material may eventually form extensive beaches or alluvial terraces, composed principally of quartz and feldspar in approximately equal proportions, or feldspathic sands, that can be economically processed to yield commercially acceptable feldspar or feldspar-silica mixtures.

The only feldspathic sand deposits now being mined in the United States are in California and Oklahoma. Other accumulations of feldspathic sands in the United States offer possibilities as future sources of feldspar supply.

Granites are widely distributed igneous rocks of plutonic origin. The granular crystalline texture of granites, although conspicuous, is much less prominent than that of pegmatites, which are believed to have been formed nearer the surface. Granites are present as major components of whole mountain ranges, and the dimensions of granite bodies can usually be stated in miles. The important constituent minerals in granites are much the same as those in pegmatites, although there are likely to be significant differences in the respective proportions. Because of economic and technologic considerations, commercial utilization of granite in the United States as a source of feldspar is not presently taking place.

TECHNOLOGY

Mining

Most feldspathic rocks can be quarried by open pit procedures. Feldspar can sometimes be recovered just by "barring down," removing loose rock with a bar, from distinctly zoned and coarse-grained pegmatitic dikes, but the majority of deposits require the use of drills and explosives. Feldspathic sand deposits are mined by dragline excavators.

Typically, different mineral species in zoned pegmatites are separated into distinct concentric shells, a natural dissociation that makes possible the selective extraction of high-purity macrocrystals, upon which the feldspar industry depended before the advent of flotation. However, by providing a means for a technological separation of the minerals in the more abundant unzoned pegmatites, flotation brought literally whole mountains of material into the category of feldspar ore.

Processing

High-grade, selectively mined feldspar from coarse-structured zoned pegmatites may be dry processed, passing consecutively through jaw crushers, rolls, and pebble mills before being subjected to high-intensity magnetic or electrostatic treatment to bring the iron content down to an acceptable level.

The customary procedure applied to most massive deposits, such as alaskite, begins with drilling, blasting, and drop-ball breaking at the quarry, followed by primary and secondary grinding and fine grinding in jaw crushers, cone crushers, and rod mills, respectively. The sequence typically continues with acid-circuit flotation in three stages, each stage preceded by desliming and conditioning. The first flotation step typically depends on an amine collector to float off and remove mica, and the second uses sulfonated oils to separate iron-bearing minerals, most notably garnet. The third step, flotation with another amine collector, leaves behind a residue that consists chiefly of quartz. Sometimes the third step is bypassed, leaving a feldspar-silica mixture, which can be used with little or no additional processing as furnace-feed ingredients in the manufacture of glass.

Feldspathic sands, such as beach sands, are usually beneficiated by froth flotation. Reduction in particle size may not be necessary, and if little or no mica is present, the first flotation step may be bypassed so that the mill feed may go directly to the conditioning step before the stage of garnet removal. It may sometimes also be desirable to omit the final flotation step, the separation of feldspar from quartz; in this case, the product may be marketed as a feldspar-silica mixture, usually for consumption in glassmaking.

The flotation-cake feldspar or feldspar-silica mixture, whether from sands or hard rock, is dewatered in filters or drain bins and dried in rotary driers for use as glass-grade feldspar. Some material is further ground in pebble mills as pottery spar and for other uses.

Products for Trade and Industry

By combining different proportions of the principal types of feldspar mined, usually after beneficiation, suppliers are able to

Table 2.—Feldspar supply-demand relationships, 1973–83

(Thousand short tons)

	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
					WORLD PRODUCTION						
Mine production:											
United States	792	763	670	740	734	735	740	710	665	615	710
Rest of world	2,258	2,556	2,225	2,343	2,506	2,610	2,692	2,771	2,891	[p]3,130	[e]3,168
Total	3,050	3,319	2,895	3,083	3,240	3,345	3,432	3,481	3,556	[p]3,745	[e]3,878
					COMPONENTS AND DISTRIBUTION OF U.S. SUPPLY						
U.S. mines	792	763	670	740	734	735	740	710	665	615	710
Imports	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Industry stocks, Jan. 1[e]	249	262	239	NA	NA	NA	NA	NA	NA	NA	NA
Total U.S. supply	1,041	1,025	909	740	734	735	740	710	665	615	710
Distribution of U.S. supply:											
Industry stocks, Dec. 31[e]	262	239	NA	NA	NA	NA	NA	NA	NA	NA	NA
Exports	10	18	10	6	6	10	12	13	14	11	9
Industrial demand	769	768	660	734	728	725	728	697	651	604	701
Apparent surplus (+), deficit (−)	...	...	+239	...	...	...	...	...	...	...	...
					U.S. DEMAND PATTERN						
Glass (container and fiber)	404	407	339	492	414	397	406	404	369	337	410
Pottery and related products	297	300	257	222	254	284	312	276	264	251	268
Other[2]	68	61	64	20	60	44	10	17	18	16	23
Total demand	769	768	660	734	728	725	728	697	651	604	701

[e]Estimated. [p]Preliminary. NA Not available.
[1]Less than ½ unit.
[2]Includes porcelain enamel, soap and abrasives, fillers, etc.

provide feldspar consumers with products meeting a considerable latitude of specifications: for example, spar with potash-to-soda ratios ranging from less than 1 to 1 to more than 5 to 1, as well as spar containing a minimum of iron and not exceeding specified limits of free quartz.

Current Research and Applications

The Bureau of Mines has published several reports in recent years as part of a research program aimed at recovering alumina from nonbauxitic resources. For example, a lime-sinter, caustic leach technology for anorthosite, a lime-soda-feldspar rock, was investigated. Leaching the sinter with 10% soda ash at 140° F extracted 85% to 90% of the alumina (*2*).

In another research project on anorthosite, the Bureau of Mines developed a flowsheet, including leaching with hydrochloric and fluosilicic acids followed by crystallization of aluminum chloride. Approximately 90% of the aluminum values were recovered from the anorthosite (*3*).

The possibility of using beneficiated flotation feldspar tailings as a replacement for some of the traditional feldspar and flint, or quartz, in a vitreous sanitary ware body was investigated. The unfired and fired properties of a control casting body containing 35% feldspar and 15% flint were successfully matched by a body containing 23.5% feldspar, 10.5% flint, and 16% feldspar tailings (*4*).

USES

There is no significant consumption of feldspar in the form of ore. Processed feldspar is added to glassmaking formulas for its alumina and alkali contents. Alumina enhances the workability of molten glass and improves the finished product by giving it better chemical stability and inhibiting any tendency toward devitrification. The increased workability facilitates the operation of automatic machines for shaping jars and bottles, materially reducing the spoilage ratio. Greater chemical stability broadens the usefulness of the containers.

Feldspar is used in ceramic mixtures, such as those for the making of vitreous china and porcelain enamels, principally as a flux. It fuses at a temperature below the melting point of most of the other ingredients and enters with them into complex physical and chemical reactions. It also performs as a vitreous binder to cement together the particles of the various crystalline substances present.

Feldspar serves advantageously in abrasives and scouring soaps because of its angular fracture and intermediate hardness. Its characteristic two directional cleavage forms sharp-edged, gritty particles hard enough to abrade and loosen many objectionable surface accumulations yet soft enough to avoid injury to the article being cleaned. Feldspar is also used as a filler in paint, foam rubber, and plastics, although tonnages are fairly small.

The pattern of feldspar end uses in the rest of the world is qualitatively similar to that in the United States.

SUPPLY-DEMAND RELATIONSHIPS

Components of Supply

The United States is self-sufficient in feldspar and no supply problem exists. No significant changes in output have occurred during the past decade and demand has been steady.

U.S. and World Production

U.S. production of feldspar in 1983 was 18% of the estimated world total.

Feldspar has never been included in the Government's stockpiling program. For the most part, feldspar producers and consumers maintain no more than normal working stocks of the mineral.

Major foreign-producing countries of feldspar in 1983 included Italy, with 23% of the estimated world total, the Federal Republic of Germany with 10%, the U.S.S.R. with 9%, and France with 5%. The high production share for Italy probably includes aplite and feldspathic sand as well as feldspar. At least 39 other countries were reported or presumed to have produced feldspar in 1983.

Feldspar production outside of the United States coincides geographically with the centers of demand and is concentrated in the industrially advanced nations of Europe. In Japan, a principal center of glass and ceramics enterprises, the majority of manufacturers accept aplite as a feldspar substitute, and consequently, the feldspar industry there is relatively subordinate. In-

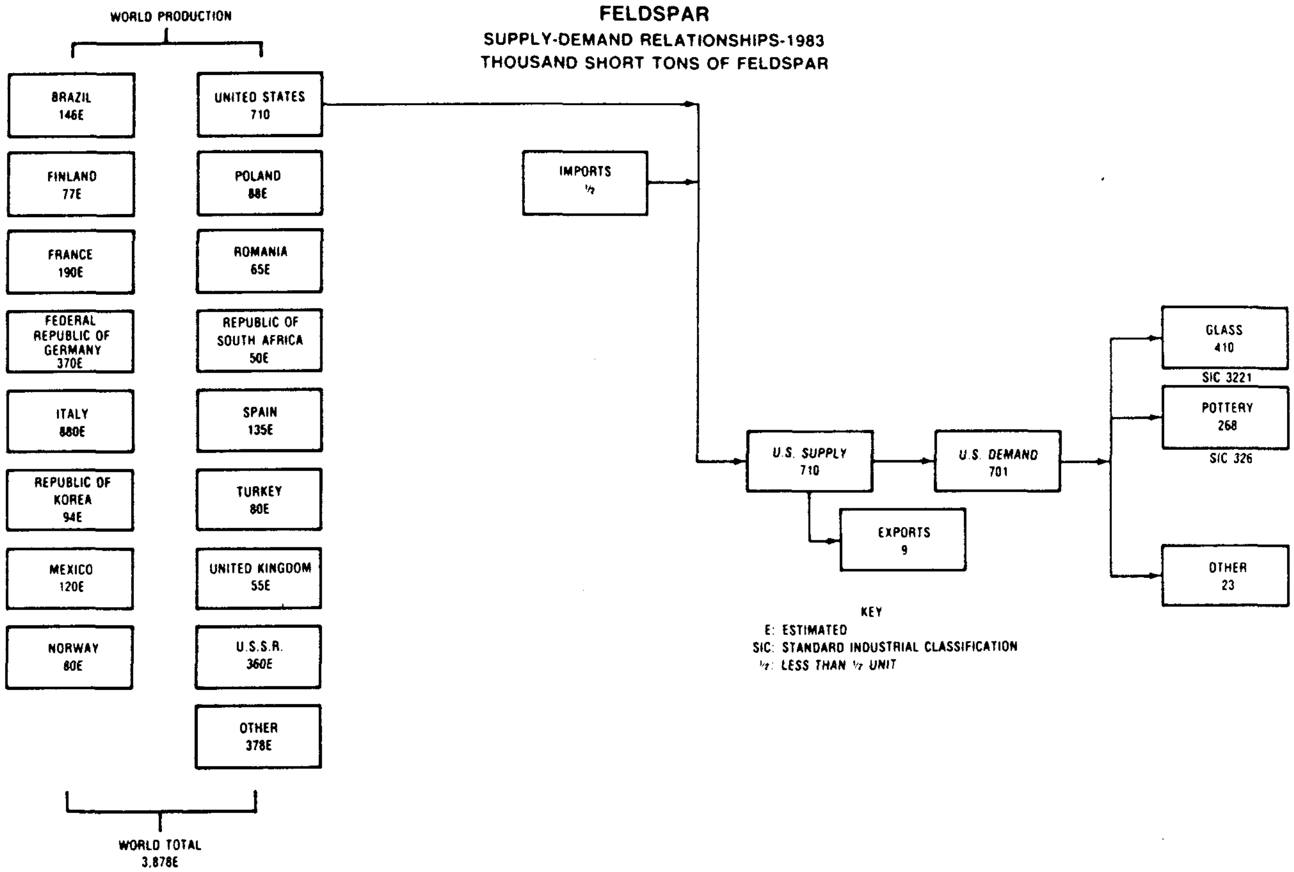

Figure 1.—Supply-demand relationships for feldspar, 1983

formation concerning the feldspar situation in China is somewhat limited, but it can be inferred that domestic needs are supplied, for the most part, from internal sources. Production of feldspar is still developing in Africa and Oceania, in proportion to the limited commercial activity and consequent small demand for the commodity in those areas.

U.S. and World Consumption

U.S. demand for feldspar is concentrated chiefly in the glass- and ceramics-manufacturing areas of the Northeastern, Middle Atlantic, and Southeastern States. Additional centers of feldspar demand, of importance even though secondary in rank, are located in California and the Midwestern States.

A published report contains extensive information on U.S. and world feldspar production and consumption, including information on output and producing companies in individual countries and import and export tables for a number of countries (*5*).

World Trade

Feldspar is not important in U.S. foreign trade. In some areas, particularly in the Northeastern States, a significant proportion of demand is satisfied by an alternative mineral product, nepheline syenite, imported from Canada.

Feldspar is a relatively low-priced, bulk source of pure alumina and alkalis that usually can be produced near the glass or ceramic consumer. Feldspar appears prominently in the international trade of only a limited number of closely grouped countries; for example, those of Western Europe.

Secondary Sources or Recycling

Small quantities of scrapped ceramics and/or refractory shapes may be saved for use as grog, which is pulverized broken pottery added to clay to reduce the shrinkage resulting from the loss of water during firing. However, the most significant secondary utilization of feldspar-consuming products is the recycling of glass containers, either broken up as cullet for remelting to make new bottles, foamed glass, and glass wool for insulation, or crushed for use in road surfacing mixtures known as "glasphalt," terrazzo flooring, bricks, building blocks, and ornamental panels. An estimated 1 billion glass bottles are now being recycled annually by the largest U.S. bottle manufacturer. Even larger numbers of recycled bottles are expected in the future.

Substitutes

The raw materials most often substituted for feldspar in a number of end uses are "Virginia Aplite" and nepheline syenite. Virginia Aplite, a granitic rock of indefinite composition containing a high proportion of plagioclase feldspar, is mined in Virginia and used mostly in glassmaking. Nepheline syenite is a coarse crystalline rock resembling granite but consisting principally of feldspathoid minerals—sodium-potassium feldspars and nepheline—with little or no free quartz. All of the nepheline syenite consumed in the United States in the manufacture of glass and ceramics and in filler applications is imported from Ontario, Canada.

Other materials that can serve effectively as subsitutes for feldspar in the glass and ceramics industries include talc,

Table 3.—U.S. feldspar byproduct and coproduct relationships in 1983

(Thousand short tons)

Principal mine product	Coproduct and/or byproduct	Quantity	Percent of total output
Feldspar	Mica	34	24
Do.	Silica sand	[e]500	(1)
Do.	Feldspar	521	73
Glass sand	do.[2]	[e]60	[e]9
Lithium	do.	W	W
Mica	do.	W	W

[e]Estimated. W Withheld to avoid disclosing company proprietary data.
[1]Less than 1%.
[2]Exists as a coproduct with glass sand and is not necessarily separated from glass sand.

Table 4.—Time-price relationships for feldspar

Year	Average annual price,[1] dollars per short ton: Actual prices	Average annual price,[1] dollars per short ton: Based on constant 1983 dollars
1963	8.98	27.02
1964	8.19	24.27
1965	8.94	25.93
1966	9.56	26.86
1967	10.28	28.04
1968	11.05	28.87
1969	11.75	29.20
1970	13.27	31.30
1971	13.42	30.14
1972	14.16	30.54
1973	16.20	33.04
1974	14.94	28.00
1975	17.51	30.02
1976	23.70	38.62
1977	23.42	36.06
1978	24.76	35.50
1979	29.00	38.27
1980	32.70	39.52
1981	31.60	34.92
1982	33.00	34.40
1983	31.70	31.70

[1]Prices are for crude feldspar, 1963-75, and semiprocessed feldspar, 1976-83.

pyrophyllite, electric-furnace slag, lithospar, which is a naturally occurring mineral mixture of feldspar and spodumene, and Cornwall stone.

BYPRODUCTS AND COPRODUCTS

Feldspar was obtained as a coproduct in 1983 from mining and processing lithium ores and weathered pegmatite ore containing mica. Coproduct recovery of mica and silica sand was reported by feldspar processors.

ECONOMIC FACTORS

Prices

The constant dollar price for feldspar has shown no significant changes since 1963 except that it has dropped since 1980. Engineering and Mining Journal, December 1983, gave prices for feldspar finished product, per short ton, f.o.b. mill, carload lots, bulk, North Carolina, ranging from $29 for 20-mesh material to $70 for 200-mesh material.

Tariffs, Taxes, and Depletion Provisions

The domestic feldspar industry is subject to no special taxes other than those applicable to the mineral industry in general. A depletion allowance of 14% is granted on domestic and foreign production.

Feldspar is a relatively inexpensive commodity that is largely sold in bulk and moved by rail hopper cars. Cost of transportation can have a considerable effect, comprising 50% or more of the total delivered cost of feldspar. Truck competition has emerged and has been handling some of the transportation of feldspar products (*6*, pp. 16, 17). Most feldspar products are shipped less than 1,000 miles. An exception is premium-grade, high-potash feldspar (*7*, pp. 719, 720).

OPERATING FACTORS

Operations of the feldspar industry are subject, to the same extent as other mineral-related activities, to the antipollution controls of the Environmental Protection Agency (EPA) and to the industrial hygiene and safety rules of two agencies of the Department of Labor, the Mine Safety and Health Administration (MSHA) and the Occupational Safety and Health Administration (OSHA).

Feldspar mining and processing do not give rise to major disturbances of the environment or to significant resource conflicts and, for the most part, are carried out in localities well removed from sensitive urban concentrations. Except for secondary manifestations such as discarded container glass, in which feldspar is an important ingredient, the environmental and ecological impacts of the industry are minor and restricted to comparatively small areas. Nearly all feldspar mines are open pit or quarrying operations, however, which entail some landscape disruption and potential land-use conflicts.

Feldspar is essentially a silicate mineral and occurs usually in close association with masses of free silica, or quartz. Feldspar mining and primary crushing generally are well ventilated, out-of-doors operations. Indoor dry-milling of feldspar ores can call for artificial ventilation of work areas and perhaps the use of respirators by exposed personnel.

Producers have installed dust collectors, cyclones, and scrubbers, and have constructed filtration plants, settling ponds, or other means of cleaning process water before returning it to local streams (*7*).

PROBLEMS

Cost containment has been a major problem in recent years. The feldspar industry is capital intensive. Costs of energy, supplies, and labor have increased more rapidly than feldspar prices, thereby reducing the profit margin (*6*).

Transportation costs have been a major factor in the delivered cost of feldspar. For example, from 1971 to 1981, rail freight charges increased almost threefold between Spruce Pine, NC, and three other cities (Akron, OH; Dallas, TX; and Los Angeles, CA). During the same period, the f.o.b. price of feldspathic minerals increased only one-third as fast (*6*).

Table 5.—U.S. import duties

Tariff item	TSUS No.	Most favored nation (MFN): Jan. 1, 1984	Most favored nation (MFN): Jan. 1, 1987	Non-MFN: Jan. 1, 1984
Feldspar				
Crude	522.31	Free	Free	$0.50 per long ton
Ground	522.41	3.1% ad valorem	2.8% ad valorem	30% ad valorem

Table 6.—Projections and forecasts for U.S. feldspar demand by end use—2000
(Thousand short tons)

End use	1983	2000: Statistical projections[1]	2000: Contingency forecasts for United States: Forecast range: Low	2000: Contingency forecasts for United States: Forecast range: High	2000: Contingency forecasts for United States: Probable
Glass	410	505*	430	510	430
Pottery	268	420	300	420	340
Other	23	0*	0	30	30
Total	701	...	730	960	800

[1]Statistical projections, provided by the Branch of Economic Analysis, are derived from regression analyses based on 24-year historical time series data and from forecasts of economic indicators such as GNP and FRB Index. A statistical projection of zero indicates that demand will vanish at or before the year 2000, based on the historical relationship. Projection equations with a coefficient of determination (R-squared) less than 0.7 are indicated by an asterisk (*).

Beneficiation procedures currently being applied in exploiting alaskite-type feldspar rocks recover much of the feldspar present. However, the flotation schemes now in use cannot make adequate separations with mill feeds containing appreciable amounts of 200 mesh or finer material. It has become accepted practice, therefore, to subject the ore stream to a thorough desliming before each stage of the flotation process. But the rejected slimes carry into the discard tailings some of the desired feldspar mineral. The tailings build up at a fairly substantial rate, and the feldspar industry has been trying to find a use for these tailings.

Glass containers, which are a major feldspar outlet, have faced considerable competition in recent years from cans and plastic bottles. Other large end users of feldspar are ceramic products such as sanitary ware, tile, and glass fiber for insulation. Consumption in these end uses is subject to declines in the housing market.

OUTLOOK

In the "Mineral Facts and Problems, 1965 Edition" chapter on feldspar, a production forecast of 750,000 long tons, or 840,000 short tons, in 1980 was made from a 1963 base of 615,000 short tons. This compares with an actual production in 1980 of 710,000 short tons. Reasons for this lower-than-predicted output in 1980 include competition from imported nepheline syenite; the emergence of plastic containers, which compete with glass containers, feldspar's largest outlet; and slower-than-expected general economic growth between 1965 and 1980.

Demand

To forecast long-term demand for feldspar, statistical projections for 2000 were first established for the individual end uses on the basis of regression analysis of end use time series data with various economic indicators and independent forecasts of those indicators. The upper and lower limits of the forecasts ranges for the individual end uses were then determined by modifying the selected statistical projections in accordance with assumed contingencies that might raise or lower expected demand. Using this procedure, a range of 730,000 to 960,000 short tons was forecast for total U.S. feldspar demand in 2000. The most probable figure was 800,000 tons, reflecting a modest growth rate of 0.8%.

The forecast growth rate for the rest of the world was estimated from the general time trend of production data for the past 20 years. A range of 3.7 to 4 million tons was forecast for feldspar demand in 2000. The most probable level was 3.8 million tons, reflecting a growth rate of 1.0%.

Glass.—The statistical projection of 505,000 tons of feldspar for use in glassmaking in 2000 was obtained by using the Federal Reserve Board Index of Stone, Clay, and Glass as an explanatory variable.

Factors considered for the high end of the forecast range, 510,000 tons, included improved technology for lighter weight, higher quality glass bottles, and higher-than-expected growth rate in glass fibers for housing insulation, in reinforced plastics, etc.

For the low end of the forecast range, 430,000 tons, consideration was given to competition from plastic bottles, cans, and paper containers. Other factors were large quantities of recycled glass and lower-than-expected growth in glass fibers. The probable forecast demand of feldspar for glass in 2000 was placed at 430,000 tons.

Pottery and Related Products.—The statistical projection of 420,000 tons of feldspar for this category in 2000 was obtained from the estimated regression equation using New Construction Activity index as an explanatory variable. Sanitary ware is a major outlet in this category, with tile, dinnerware, electrical porcelain, etc., comprising the balance. Substantial growth in the housing market could result in 420,000 tons of feldspar, the high end of the forecast range. Sluggish growth in housing and sanitary ware and tile, coupled with a trend toward more imports of ceramic products, including tile, could result in a low end of 300,000 tons of feldspar in this category. A probable forecast of demand was set at 340,000 tons.

Other.—Other feldspar uses include those for porcelain enamels, rubber and plastics filler, soaps, scouring powders, welding rod coatings, abrasives, etc. In estimating potential feldspar demand for this heterogeneous use category in 2000, an estimated regression equation with total U.S. population as an explanatory variable was used. This category has shown a downward trend during the past 15 to 20 years. However, moderate growth of feldspar as a filler in rubber and plastics and the emergence of unforeseen new uses for the mineral could occur. This led to the selection of 30,000 tons of feldspar for the high end and also the most probable forecast in 2000.

Cumulative Requirements to 2000.—Cumulative U.S. requirements from 1983 through 2000 for feldspar, using the probable demand growth rate, total 12.8 million tons. Maintaining the same ratio of U.S. production to domestic requirements as in 1983 would predict a total cumulative output between 1983 and 2000 of 13.0 million tons.

The probable cumulative demand for feldspar in the rest of the world is 59.4 million tons, bringing the probable world demand through the forecast period to 72 million tons.

Adequacy of Supply

Feldspar is one of the most abundant minerals in the Earth's crust. The mineral is a major component of the Earth's granites. Reserve data for the United States and the rest of the world have not been determined, but the supply of feldspar is very large. In the Spruce Pine district of North Carolina alone, reserves were estimated to be at least 200 million tons. When this is compared with the probable forecast of total world cumulative demand of

Table 7.—Summary of forecasts of U.S. and rest-of-world feldspar demand, 1990 and 2000

(Thousand short tons)

	1983	2000 Forecast range: Low	2000 Forecast range: High	Probable: 1990	Probable: 2000	Probable average annual growth rate 1983-2000 (percent)
United States:						
Total	701	730	960	740	800	0.8
Cumulative[1]	—	12,200	14,200	5,060	12,800	—
Rest of world:						
Total	^{e}3,177	3,700	4,000	3,440	3,800	1.1
Cumulative[1]	—	58,600	61,200	23,300	59,400	—
World:						
Total	^{e}3,878	4,430	4,960	4,180	4,600	1.0
Cumulative[1,2]	—	70,800	75,200	28,300	72,200	—

^{e}Estimated.
[1]Round figures.
[2]Data may not add to totals shown because of independent rounding.

72 million tons in 2000, and considering the widespread world occurrence of rocks and sands containing feldspar, no resource shortage is expected.

Forecast Production to 1990 and 2000.—Straight-line projections based on 1963-83 output data suggest that U.S. feldspar production may be 718,000 tons in 1990 and 720,000 tons in 2000, but the estimates, arrived at by contingency analysis, of 750,000 tons in 1990 and 820,000 tons in 2000 are believed to be more realistic.

Possible Supply-Demand Changes

Shifts of glass and ceramics industrial centers away from the northeast section of the United States would decrease the relative importance of Canadian nepheline syenite from eastern Ontario because transportation costs to marketing areas would be greater. Shifts to the Central and Southern States might favor the establishment of facilities for extracting feldspar from local granites because of transportation advantages, even though prices of feldspar so produced might be expected to be somewhat higher to cover extra processing costs.

Greater use of coproduct feldspar might be spurred by shifts of consuming industries to regions remote from the plentiful alaskite resources now being mined, primarily in North Carolina. Feldspar-bearing sands in Illinois and perhaps elsewhere in the Central United States may become significant sources of feldspar when economical beneficiation procedures are developed.

The availability of feldspar supplies, either in the United States or in the rest of the world, seems unlikely to be restricted materially in the foreseeable future by considerations arising from land-use conflicts or from contamination of the atmosphere or water supplies. In some regions, however, additional increases in feldspar production costs can be anticipated as sequels to Federal, State, and local legislation concerning mine-waste disposal and rehabilitation of mined-out areas. On the other hand, to the extent that feldspar can be produced as a coproduct from other operations, its recovery in that manner will tend to diminish the quantities of solid mineral wastes for disposal.

Possible Technological Progress

Nearly all feldspar mining in the United States is from open pit operations, so that innovations in surface mining methods or equipment would benefit the feldspar industry by making it possible to reduce production costs. The major area of possible technologic advances in the near future, however, appears to be in the field of beneficiating various feldspathic rocks to obtain salable feldspar raw materials.

The demand for high-potash grades of feldspar, especially for use in the manufacture of television-tube glass, vitrified china, and insulators for high-voltage electrical applications, points out the need to develop methods of separating abundant, naturally occurring soda-potash feldspar into soda spar and potash spar.

Table 8.—Comparison of U.S. feldspar production and demand, 1963–83, 1990, and 2000

(Thousand short tons)

Year	U.S. demand	U.S. production
1963	599	615
1964	647	658
1965	664	700
1966	704	734
1967	663	689
1968	731	748
1969	793	755
1970	648	726
1971	702	743
1972	681	746
1973	769	792
1974	768	763
1975	660	670
1976	734	740
1977	728	734
1978	725	735
1979	728	740
1980	697	710
1981	651	665
1982	604	615
1983	701	710
1990	[1]740	[2]718 ^{e}750
2000	[1]800	[2]720 ^{e}820

^{e}Estimated.
[1]Probable forecast from table 7.
[2]21-year trend.

Improvements in feldspar flotation plants are needed. Present grinding schemes produce fine material, or slimes, which interfere with the flotation separation and must be removed before each flotation step. Also, feldspar is lost with the waste tailings. Technologic developments are needed in this area to improve feldspar recovery. Attempts have been made to find uses for the substantial quantities of feldspar tailings presently being generated. Another area of needed research, in the flotation process itself, would involve finding a substitute for hydrofluoric acid, which is very corrosive and difficult to handle.

Since a number of products in which feldspar is used also require silica as an accompanying material, increasing utilization of feldspar-silica mixtures may occur, suggesting a consequent reduction in the extent of beneficiation involved. In some cases, treatment of feldspathic materials might be limited to that required for the elimination of iron minerals and perhaps a few other unwanted substances.

Granites, widely distributed and available in large quantities, are potential major feldspar resources, although under present circumstances most operators have found it only marginally profitable to recover feldspar-silica mixtures from that source, even by taking advantage of waste granite already mined and partially ground in the production of building stone. Shifts of industry into geographic areas where alaskite and pegmatite deposits either do not exist or else are not conveniently accessible could stimulate research that might make major-scale exploitation of granites for their feldspar and silica contents more economically attractive in the future.

Greater attention to feldspar byproduct-coproduct possibilities may occur in the future because of competitive pressure to obtain the maximum return from the exploitation of mineral deposits, and increasingly as a consequence of restrictions on disruptions of the environment. In many cases, the cost of necessary processing of the waste materials generated may be offset by the value of the salable products recovered, so that often it will be more economical to prepare them for market than to develop alternative disposal procedures.

As new technology is developed in various glass and ceramic industries, the feldspathic industry will be challenged to produce improved products. New markets will also be important to the feldspar industry in maintaining growth and profitability in the future.

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