AN OCCURRENCE OF DETRITAL AUTHIGENIC FELDSPAR

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INTRODUCTION

A sample of fine sand collected from the bottom of a 27-foot water well in a lacustrine plain covered by the Flint moraine, near Mt. Morris, Michigan, SW $\frac{1}{4}$, NW $\frac{1}{4}$, Section 6, T. 8 N., R. 7 E., Genesee Township, has yielded an interesting suite of minerals, including detrital authigenic feldspar. The finding of such feldspar in the drift introduces the problem of the source of the authigenic grains.

Authigenic feldspars have been recorded as a constituent of certain arenaceous and calcareous rocks. Boswell[1] lists 50 references, only two of which mention authigenic feldspars in North America. Daly[2] noted the presence of what we now call authigenic orthoclase in a dolomite in Alberta. He was the first to make a study of such an occurrence in North America.[3] Authigenic grains have been observed also in certain calcareous rocks in North Carolina.[4] Singewald and Milton[5] noted authigenic feldspars in New York. Derry[6] recorded the presence of probable authigenic feldspars, microcline and albite and possibly orthoclase, in Ontario. Goldich[7] reported such feldspars from Minnesota, and mentioned occurrences in Wisconsin and Missouri. He states,[8] "The nuclei of the great majority of the grains seem to be triclinic potash feldspar, microcline. The marginal growths, however, appear to be more nearly the monoclinic variety, orthoclase . . . ." Tester and Atwater[9] discussed the occurrence of authigenic feldspars in sediments, noting them in

[1] Boswell, P. G. H., *On the Mineralogy of Sedimentary Rocks*, Thomas Murby and Co. 393 pp., **1933.**

[2] Daly, R. A., Geology of the North American Cordillera at the forty-ninth parallel: *Canada Geol. Surv., Mem.* **38,** Part I, pp. 52–54, 1912.

[3] Daly, R. A., Low-temperature formation of alkaline feldspars in limestone: *Proc. Nat. Acad. Sci.*, vol. **3,** pp. 659–665, 1917.

[4] Loughlin, G. F., Berry, E. W., and Cushman, J. A., Limestones and marls of North Carolina: *North Carolina Geol. and Econ. Surv., Bull.* **28,** principally pp. 20, 53 and 58, 1921.

[5] Singewald, J. T., Jr., and Milton, Charles, Authigenic feldspar in limestone at Glens Falls, New York: *Bull. Geol. Soc. Amer.*, vol. **40,** pp. 463–468, 1929.

[6] Derry, D. R., Heavy minerals of the Ordovician sediments of Ontario: *Jour. Sed. Pet.*, vol. **4,** No. 2, pp. 85–86, 1934.

[7] Goldich, S. S., Authigenic feldspar in sandstones of southeastern Minnesota: *Jour. Sed. Pet.*, vol. **4,** No. 2, pp. 89–95, 1934.

[8] *Op. cit.*, pp. 90–91.

[9] Tester, A. C., and Atwater, G. I., The occurrence of authigenic feldspars in sediments: *Jour. Sed. Pet.*, vol. **4,** No. 1, pp. 23–31, 1934.

Iowa, Kansas, Minnesota, Wisconsin, and New York. They remark,[10] "Authigenic feldspar can be used to differentiate horizons as it frequently occurs as a 'flood' mineral in the lighter fractions of a mineral separation." Atwater and Clement[11] described such feldspars from Wisconsin and Minnesota. Thiel[12] reported occurrences in Wisconsin, Minnesota, Illinois, Missouri, and Arkansas. Stringham[13] has noted their presence in Utah and Tyler[14] recorded their occurrence in Wisconsin. Gruner[15] has noted small particles of feldspar which are probably authigenic in certain Minnesota rocks.

Method of Study

The sand was separated into two fractions using acetylene tetrabromide (G. = 2.95) which were then washed in benzene and dried in beakers on a hot plate. The heavy minerals were mounted in Canada balsam. The light fraction was immersed in a solution of acetylene tetrabromide and benzene whose specific gravity was such that a fragment of microcline would float and a chip of quartz would settle. A very satisfactory separation of the feldspars and quartz was obtained. The two fractions, feldspars and quartz, were washed in benzene and dried on a hot plate, after which the specimens were bottled in suitably labeled vials. The grains were examined microscopically in 1.54 index liquid, without a cover glass. Authigenic grains were separated from the other feldspars with a needle and washed in a drop of benzene in a small watch glass. Individual grains, taken up with a needle, were then pressed into warmed dry Canada balsam, the slide reheated, and the cover glass added.

Seventy slides of feldspar fractions were examined from which 14 grains of detrital authigenic feldspar were removed, and 12 mounted. Eight slides of heavy concentrates were studied.

Minerals in the Sand

The following minerals have been identified in the glacial sand: Actinolite, albite, apatite (well-rounded to slightly rounded prismatic grains),

[10] *Op. cit.*, p. 27.

[11] Atwater, G. I., and Clement, G. M., Pre-Cambrian and Cambrian relations in the Upper Mississippi Valley: *Bull. Geol. Soc. Am.*, vol. **46,** p. 1677, 1935.

[12] Thiel, G. A., Sedimentary and petrographic analysis of the St. Peter Sandstone: *Bull. Geol. Soc. Am.*, vol. **46,** pp. 589–592, 1935.

[13] Stringham, Bronson, An occurrence of feldspars replacing fossils (Abs.): *Am. Mineral.*, vol. **21,** No. 3, p. 200, 1936.

[14] Tyler, S. A., Heavy minerals of the St. Peter Sandstone in Wisconsin: *Jour. Sed. Pet.*, vol. **6,** No. 2, p. 82, 1936.

[15] Gruner, J. W., Unusually high feldspar content of the Glenwood formation (Abs.): *Am. Mineral.*, vol. **22,** No. 3, p. 212, 1937.

augite (light green), titaniferous augite (?), biotite, brookite, rhombohedral carbonate, chalcopyrite, chert (angular to well-rounded), enstatite, epidote, feldspar (unidentified species altered to kaolin and sericite), garnet (colorless, pink, and darker reddish shades), hematite, green hornblende, hypersthene (rounded to prismatic grains, exhibiting strong pleochroism), ilmenite, kyanite, leucoxene, limonite, magnetite, microcline (as nuclei about which another feldspar has formed; also, as well-rounded to angular grains, the well-rounded type being the most common), muscovite, orthoclase, quartz (well-rounded to angular; some grains doubly terminated; often containing inclusions of rutile needles, tourmaline and apatite crystals), pyrite, rutile, sphene (light to dark brown; often rounded), staurolite, brown tourmaline (well-rounded to prismatic grains), blue tourmaline, zircon (rounded to prismatic grains), and zoisite.

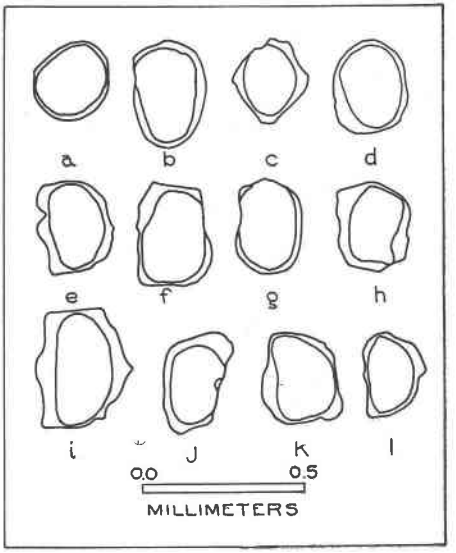

FIG. 1. Sketches of authigenic feldspar.

AUTHIGENIC FELDSPAR

Fourteen grains of slightly altered authigenic feldspar were noted in the slides studied, and twelve of these were examined microscopically. Figure 1 illustrates the shapes and sizes of the grains. About a nucleus of feldspar another feldspar whose optical character and orientation is other than that of the central grain has been formed as a marginal growth. Measurements were made with a recording micrometer of the

long and short diameters of the nuclei, and of the maximum widths of the marginal growths. The average long diameter of the nuclei is 0.272 mm., that of the short diameter, 0.183 mm., and the average of the maximum widths of the rims, 0.046 mm. The maximum long diameter of the nuclei is 0.350 mm. and the minimum, 0.225 mm. The maximum short diameter of the nuclei is 0.215 mm. and the minimum, 0.155 mm.

Grains *a*, *b*, *c*, *d*, *e*, and *g* have nuclei of microcline showing excellent quadrille structure, and yield poor interference figures. The character of the nuclei is biaxial negative. The majority of the other feldspar grains exhibit indistinct twinning lamellae or none at all. The marginal growths of grains *f*, *i*, *j*, *k*, and *l* are considered to be adularia. Good biaxial negative interference figures with very small optical angles were obtained from these specimens. The composition of the rims of the other grains is probably potash feldspar, although sufficient data for exact determinations were not possible.

Probable Source of the Authigenic Feldspar

The authigenic feldspar is found in a lacustrine plain which is covered by the Flint moraine, laid down by the Saginaw ice lobe of the Wisconsin ice sheet. Taking into consideration the direction of ice movement the location of the source of this feldspar is limited to a certain extent. It is possible that the feldspar source is in Ontario, but because of its slightly altered condition and relatively abundant occurrence in the sediment the source in Michigan rocks seems more likely. The strata over which this lobe passed include the common sedimentary rock types, varying in age from Devonian through Pennsylvanian. A study of residues of certain rocks from the strata of the Paleozoic formations is contemplated with the expectation that the source of the authigenic grains may be found.

Acknowledgments

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NOMINATIONS FOR OFFICERS OF THE MINERALOGICAL SOCIETY OF AMERICA FOR 1938

The Council has nominated the following for officers of *The Mineralogical Society of America* for the year 1938:

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The eighteenth annual meeting of the Society will be held December 28–30, 1937, at the Hotel Washington, Washington, D.C.

A preliminary list of the titles of papers to be presented before the Society at its annual meeting will be published in the December issue of *The American Mineralogist*. Titles of papers should be in the hands of the Secretary by *November 8th.*

Printed programs containing a schedule of the papers to be presented at the annual meeting, together with the abstracts of the papers, will be mailed to all members of the Society with the December issue of the *Journal*. Abstracts for this program, *in duplicate*, should be in the hands of the Secretary by *November 20th*. Abstract blanks may be obtained from the Secretary on request.

PAUL F. KERR, *Secretary*

BOOK REVIEWS

A DESCRIPTIVE PETROGRAPHY OF THE IGNEOUS ROCKS, VOLUME III—THE INTERMEDIATE ROCKS. ALBERT JOHANNSEN, pp. 350+xiv. The University of Chicago Press, Chicago, **1937,** price $4.50.

This volume describes the rocks from syenite to gabbro; or in Shand's classification the saturated rocks, together with the rocks that are oversaturated with respect to the bivalent elements excluding the ultramafic rocks; or families 9 to 12 of Johannsen which include those rocks with essential feldspar that lack essential quartz and feldspathoids.

This volume follows the same plan as volume II and it maintains the same high quality. The statements made by the reviewer on the second volume[1] apply to the third volume.

The historical sketches showing the origin and development of our rock names, the changes in meaning and nomenclature with time, and the differences in usage at the present time by different nations or groups are valuable and show the author's scholarly knowledge of the literature, old and new. The numerous photographs of petrographers, the microphotographs and photographs of rocks, and the many chemical analyses and modes are of great value.

The reviewer is shocked at the frequent use of acid and basic for the plagioclases and rocks. Why not use sodic and calcic or Johannsen's sodiclase and calciclase for the plagioclase and the specific term that happens to be appropriate for the rock, such as silicic or mafic? In quoting Daly, the author nearly always refers to old publications of Daly, mostly of 1914 or older, while much new data are given by Daly in "Igneous Rocks and the Depths of the Earth," published in 1933.

[1] Larsen, E. S., *Am. Mineral.*, vol. **18,** p. 311, 1933.