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Memorial of Joseph W. Greig
1895–1977

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Joseph W. Greig, Visiting Professor of Geochemistry at The Pennsylvania State University, died at the William Penn Nursing Center in Lewistown, Pennsylvania, on Saturday, October 22, 1977. He is survived by his daughter Barbara of Washington, D.C., and by a brother George K. Greig of Calgary, Alberta.

Dr. Greig was born in Ontario, Canada, in 1895, the son of David and Margaret Kerr Greig. He attended schools in Ontario and Alberta and studied geology and mineralogy at Queen's University in Kingston, Ontario, followed by graduate work at Columbia University and later at Harvard, where he received the Ph.D. degree in 1927. He served overseas as a gunner and Lieutenant with the Canadian Field Artillery, 1915–1919. After the war he spent several seasons on exploration geology in northern Canada with field parties of the Geological Survey of Canada and the Ontario Department of Mines. He retained a strong interest in the Canadian northland through his life; he travelled through the north country by canoe and collected books relating to the subarctic and the early explorers and fur trade.

Joseph Greig's professional work was done mainly at the Geophysical Laboratory of the Carnegie Institution of Washington and later at Penn State. He was one of the pioneers in high-temperature phase equilibrium studies of oxide and sulfide systems and in applications to geology and to the properties of industrial slags and refractories.

With N. L. Bowen he determined the phase relations in the system Al_2O_3–SiO_2. Of particular interest in this study was their demonstration that sillimanite is not a stable phase at atmospheric pressure, as had been believed, but that the compound $3Al_2O_3 \cdot 2SiO_2$ does exist and is a common and very important phase in aluminosilicate refractories. Later Bowen, Greig, and Zies described a mineral having this composition and named it mullite from its occurrence on the Island of Mull, Scotland. The most outstanding contribution of Greig was his comprehensive study of liquid immiscibility in silicate systems. This study eliminated liquid immiscibility as a common method of differentiation in igneous rocks, and also had important technological significance, *e.g.* the development of low-alumina low-alkali silica brick for improved high-temperature service in open-hearth steel furnaces. Greig's studies of the equilibrium relations among Fe_2O_3, Fe_3O_4, and oxygen were a fundamental basis for the interpretation of the occurrence of iron oxides in nature and also had important applications in steelmaking. With T. F. W. Barth he studied the experimentally difficult system nepheline–albite, and the results of this study have been of great use in the geological interpretation of relations between feldspathoids and feldspars.

During the wartime years 1940–45 his work was diverted to defense matters and he acted as National Defense Research consultant on several wartime problems, including the proximity fuse, gun-barrel erosion, and high-velocity projectiles. After the war he collaborated with M. A. Tuve and others on early teleseismic investigations of crustal structure.

In 1963, a newly-discovered mineral was named "greigite" in his honor and in recognition of his contributions to mineralogy and physical chemistry. The new mineral, a magnetic iron sulfide, Fe_3S_4, was discovered in San Bernardino County, California, by the U. S. Geological Survey.

One of Joseph Greig's memorable contributions at the Geophysical Laboratory and at Penn State stemmed from his unusual ability as a scientific critic. Many graduate students and colleagues came to him for advice and guidance and appreciated the value of his critical analysis of their research work. He had the ability to spot points of weakness in research programs and in theses or papers being prepared for publication. In many cases, he was able to suggest simple experiments to test a proposed theory. He was even more critical of his own work and writings than he was of other research brought to his attention. For that reason, some of his work remains unpublished, even though his colleagues regarded it as complete and valuable. The unpublished work includes a comprehensive study of solid solutions in the system copper–iron–sulfur and a systematic scheme of phase notation that is used in several laboratories that allows simplified geometrical treatment of complex phase relations.

Publications of Joseph W. Greig

1924 Immiscibility in silicate melts. *Bull. Geol. Soc. Am., 35,* 124 (abstract).
(with N. L. Bowen) The system: Al_2O_3–SiO_2. *J. Am. Ceram. Soc., 7,* 238–254.
(with N. L. Bowen and E. G. Zies) Mullite, a silicate of alumina. *J. Wash. Acad. Sci., 14,* 183–191.
Discussion on immiscibility in high silica melts. *Bull. Am. Ceram. Soc., 3,* 385–386.

1925 (with N. L. Bowen) The crystalline modifications of $NaAlSiO_4$. *Am. J. Sci., 210,* 204–212.
Formation of mullite from kyanite, andalusite, and sillimanite. *J. Am. Ceram. Soc., 8,* 465–484.

1926 Formation of mullite from kyanite, andalusite, and sillimanite. *Am. J. Sci., 211,* 1–26.
(with R. W. G. Wyckoff and N. L. Bowen) The X-ray diffraction patterns of mullite and of sillimanite. *Am. J. Sci., 211,* 459–472.

1927 Woman and Narrow Lakes Area, District of Kenora, *Ontario Dept. Mines Annual Report, 36,* 85–110.
Immiscibility in silicate melts. *Am. J. Sci. 213,* 1–44, 133–154.
On liquid immiscibility in the system FeO–Fe_2O_3–Al_2O_3–SiO_2. *Am. J. Sci., 214,* 473–484.

1928 On the evidence which has been presented for liquid immiscibility in the laboratory and in the rocks of Agate Point, Ontario. *Am. J. Sci., 215,* 375–402.

1929 (with H. E. Merwin and E. S. Shepherd) Melting granite and basalt in the laboratory (abstr.). *Bull. Geol. Soc. Am., 40,* 94–95.

1931 (with E. S. Shepherd and H. E. Merwin) Melting temperatures of granite and basalt. *Carnegie Inst. Wash. Year Book, 30,* 75–78.

1932 Temperature of formation of the ilmenite of the Engels copper deposits—a discussion, with appendix: Description of an equilibrium diagram for a hypothetical binary system with complete solid solution at higher temperature, incomplete immiscibility at lower temperatures, and inversions in the end members. *Econ. Geol., 27,* 25–38.
The existence of the high-temperature form of cristobalite at room temperature and the crystallinity of opal. *J. Am. Chem. Soc., 54,* 2846–2849.
(with H. E. Merwin and E. Posnjak) Discussion of Widmanstatten structure III—*The aluminum-rich alloys of aluminum and copper, and of aluminum with magnesium and silicon,* by Robert F. Mehl, Charles S. Barrett, and Frederick A. Rhines. *A.I.M.M.E. Trans., 99, Institute of Metals Div.,* 229–230.

1933 (with H. E. Merwin and E. S. Shepherd) Notes on the volatile transport of silica. *Am. J. Sci., 225,* 61–73.
(with E. Posnjak) Notes on the X-ray diffraction patterns of mullite. *J. Am. Ceram. Soc., 16,* 569–583.

1935 (with E. Posnjak, H. E. Merwin, and R. B.

Sosman) Equilibrium relationships of Fe_3O_4, Fe_2O_3, and oxygen. *Am. J. Sci.*, *230*, 239–316.

1936 (with H. E. Merwin and E. Posnjak) Separation planes in magnetite. *Am. Mineral.*, *21*, 504–510.

1938 (with T. F. W. Barth) The system $Na_2O \cdot Al_2O_3 \cdot 2SiO_2$ (nephelite, carnegieite)–$Na_2O \cdot Al_2O_3 \cdot 6SiO_2$ (albite). *Am. J. Sci.*, *235-A*, 93–112.

1939 (with L. F. Brady) Note on the temperature attained in a burning coal seam. *Am. J. Sci.*, *237*, 116–119.

1948 (with M. A. Tuve and others) Studies of deep crustal layers by explosive shots. *Trans. Am. Geophys. Union*, *29*, 772.

1950 (with M. A. Tuve and others) Progress report on studies of deep crustal layers by explosive shots. *Union Geol. Geophys. International, Assoc. de Seis., Ser. A, Travaux scientifiques*, *17*, 5–6.

1952 (with L. H. Adams and others) Studies of crustal structure by explosion seismic waves near the Mesabi Range and near Puget Sound (abstr.). *Trans. Am. Geophysical Union* *33*, 315–316.

1955 (with Einar Jensen and H. E. Merwin) The system Cu–Fe–S. *Carnegie Inst. Wash. Year Book*, *54*, 129–134.