Samuel Stephen Goldich (1909 - 2000)

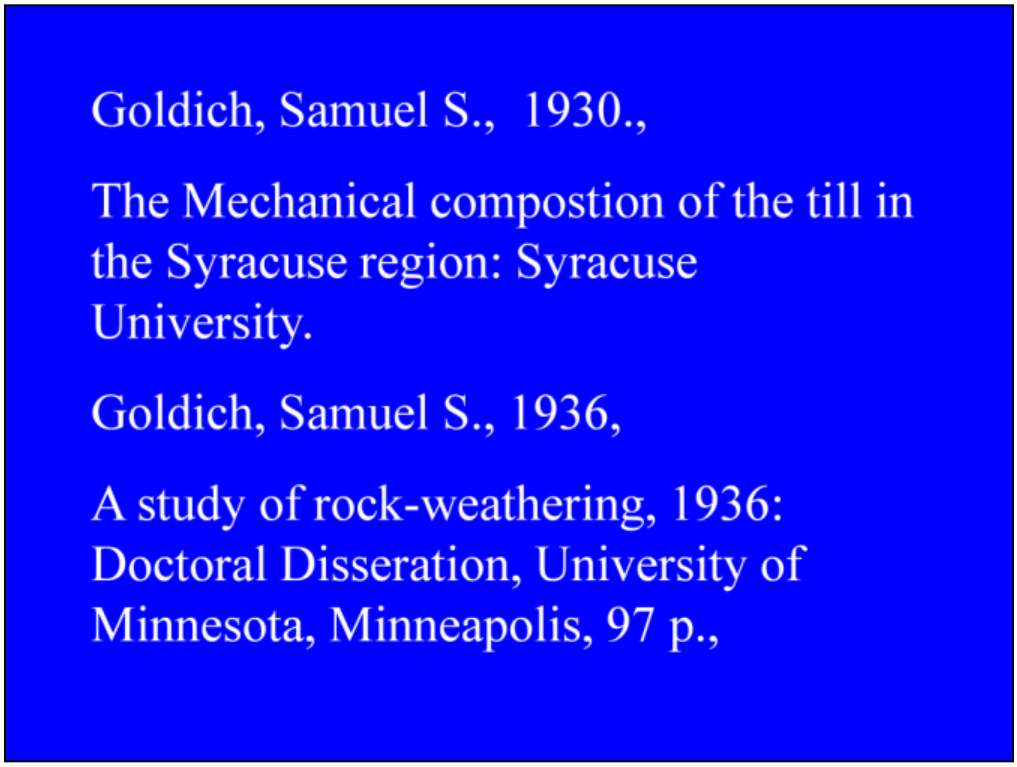
- Goldich Stability Series
- Introduced trace-element determination to earth science
- The K-Ar system or the Rb-Sr system Goldich v. Gast
- Dilatancy to help explain the discordance of the U-Th-Pb ages in zircons
- Minnesota River Valley and other area of perancient rocks
- Air abrasion method of preparing zircons

Sam Goldich after whom the Goldich Medal is named, passed away in Colorado December 2000, just short of his 92nd birth. Sam was born in North Dakota, and at an early age his family moved to Minneapolis where his father sought better educational opportunities for this children. Sam received his public schooling Minneapolis, his bachelor's degree there, and immediately began his professional career with joint publications on diabases and authigenic feldspar.

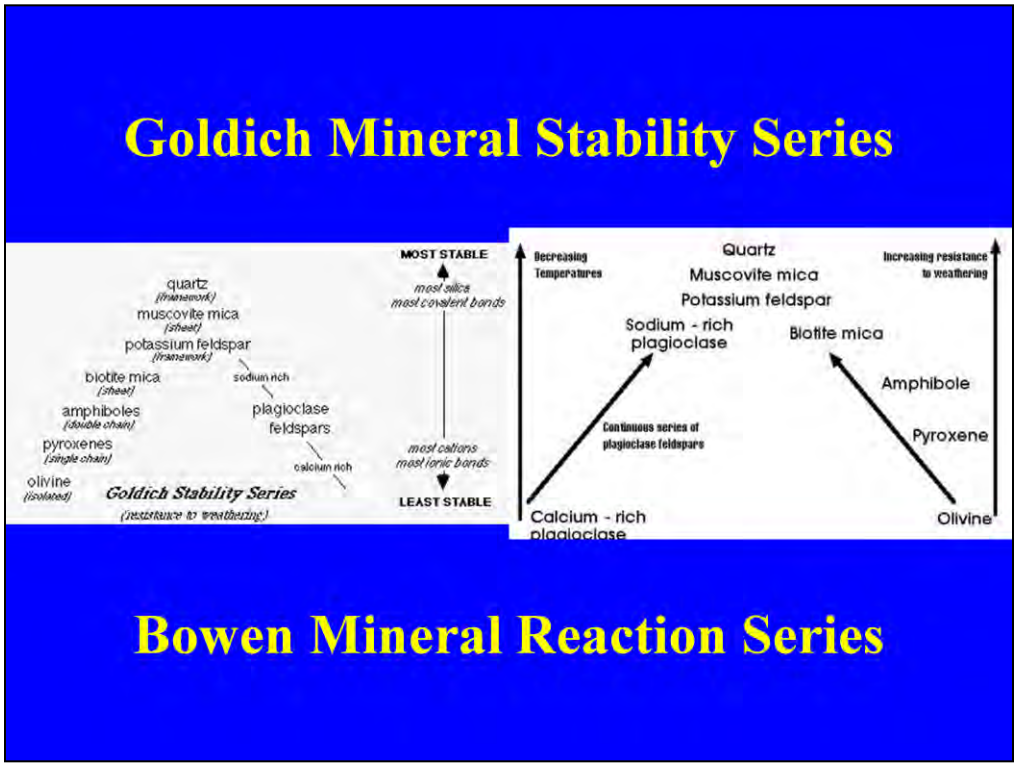
This picture is from his award of the Goldschmidt Medal of the Geochemical Society in 1983 (Geochimica et Cosmochimica Acta Vol. 48. pp. 1377-1380).

The V. M. Goldschmidt Award of the Geochemical Society is made for major achievements in geochemistry or cosmochemistry, consisting of either a single outstanding contribution, or a series of publications that have had great influence on the field.

Perhaps Sam is best known for half a dozen significant contributions to our profession: the Goldich Mineral Stability Series; use of trace elements for rock characterization; demonstrating that K-Ar ages are less susceptible to resetting during weathering than R-Sr ages; Dilantancy to explain some discordant U-Pb zircon ages, discovery of some of the most ancient rocks on earth; and in his last years refinement of the air abrasion technique for high resolution ages for U-Pb age determinations.

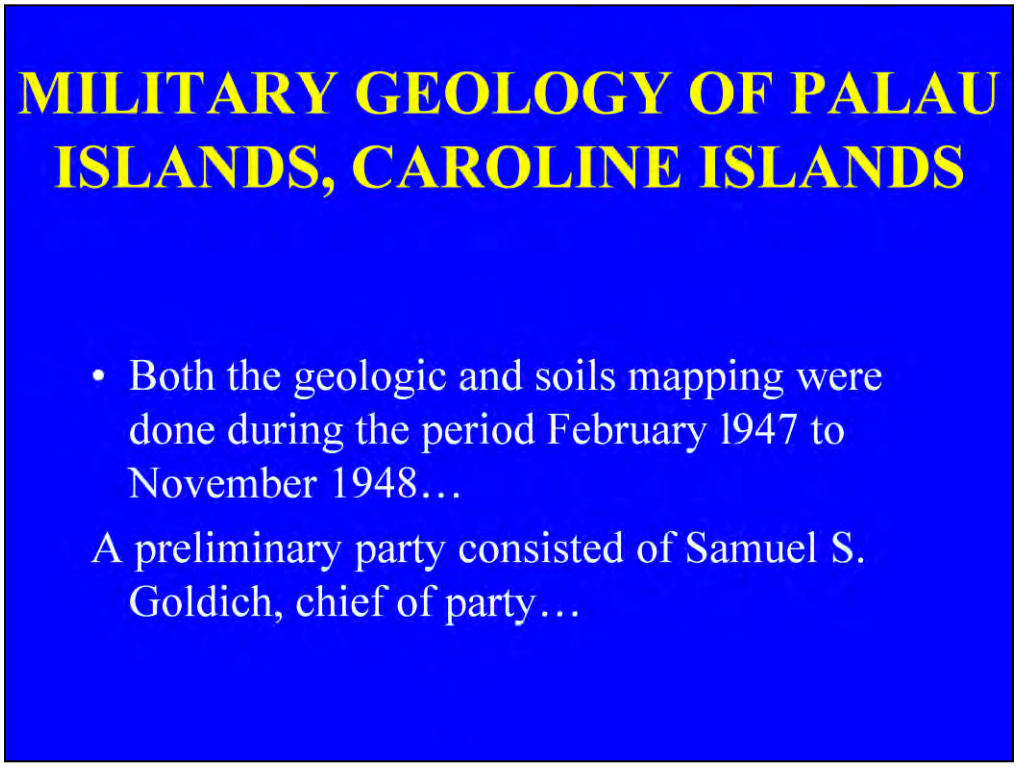


Few remember that Sam was not always a hard rock geologist. His Master's work was on glacial materials in the Syracuse, New York, area. He returned to Minnesota, approached Frank Grout to be his dissertation advisor—Frank gave him a box of ideas—Sam chose weathering….and all else is history.



Sam's PhD work is probably best known throughout geology as first proposing and demonstrating what is now known as the Goldich Mineral Stability Series, or which minerals weather first and which last….In essence, the reverse of the Bowen Reaction Series which describes which minerals crystalize first and which crystalize last. This understanding of weathering and modern processes led Sam into military geology during World War II. He worked extensively in Arkansas and other areas of the southern US, the Caribbean islands, Brazil and the South Pacific looking for commercial bauxite for aluminum.

His pioneering work in Differential Thermal Analysis (or DTA) was undertaken in the Caribbean during World War II. DTA is a thermoanalytic technique, in which the material under study and an inert reference are made to undergo identical thermal cycles, while recording any temperature difference between sample and reference. This technique permits the quantitative analysis of various minerals found in bauxite. The principal concern of the US Ambassador was the quantity of "dirt" Sam send with the diplomatic pouch back to Washington for confirmatory analysis.



Late in World War II, Sam was in the first wave of non-combatants onto Palau.for further evaluation of bauxite for aluminum.

Palau Island,
Caroline Island Group

PELELIU, *showing base development. At the time photograph was taken, jungle growth had again covered the ridges of Umurbrogol Pocket. (Aerial view, October 1946.)*

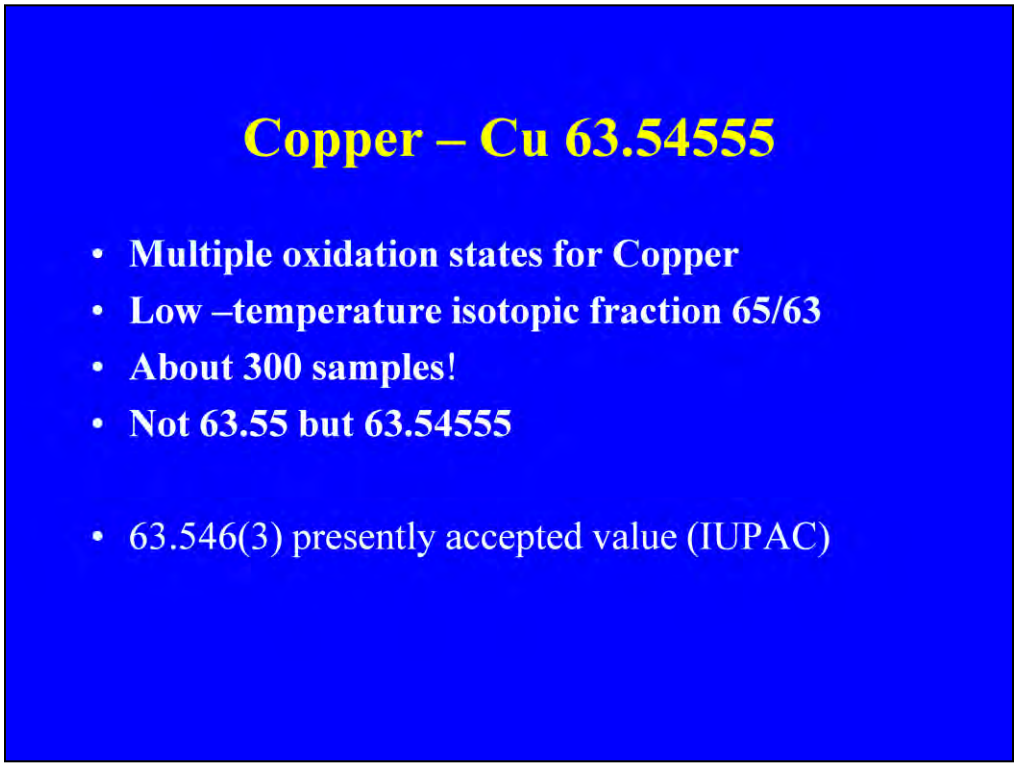
This was at the very end of World War II, and Sam participated in the surrender of some of the last Japanese soldiers.

Sam was party chief

Sam had a motion picture camera at that time, and the reminiscent of films from "South Pacific)! Apparently the locale was enjoyable, but the Army forgot about his unit for several months!

Sam ultimately returned to Minnesota in the late 1940s, after a brief stay at Texas A&M and some work in West Texas, took over from Frank Grout and George Schwartz advising petrology students, and in the early 1950s was one of the original sparks behind the Institute on Lake Superior Geology. In the early 1950s, Sam became enamored with geochronology. Sam had been hearing and reading about agew determinations from people kindividuals such as Arthur Holmes. Sam was a very good chemist learning under Frank Grout in the 1930s, and initiated much of the high quality early work in K-Ar and Rb-Sr. He teamed up with Alfred Nier of the Physics Department and with Bill Shields of the National Bureau of Standards, helped develop the modern mass spectrometer.

One of Sam's and Nier's significant contributions (Goldich, S. S., Nier, A. O., Washburn, A. L., A (super 40) /K (super 40) age of gneiss from McMurdo Sound, Antarctica, Transactions - American Geophysical Union, 39 (5), p. 956-958, 1958) provided key data that old crustal gneiss underlay the ice of Antarctica. Prior to this work, it was generally speculation of whether Antarctica should be considered a continent.



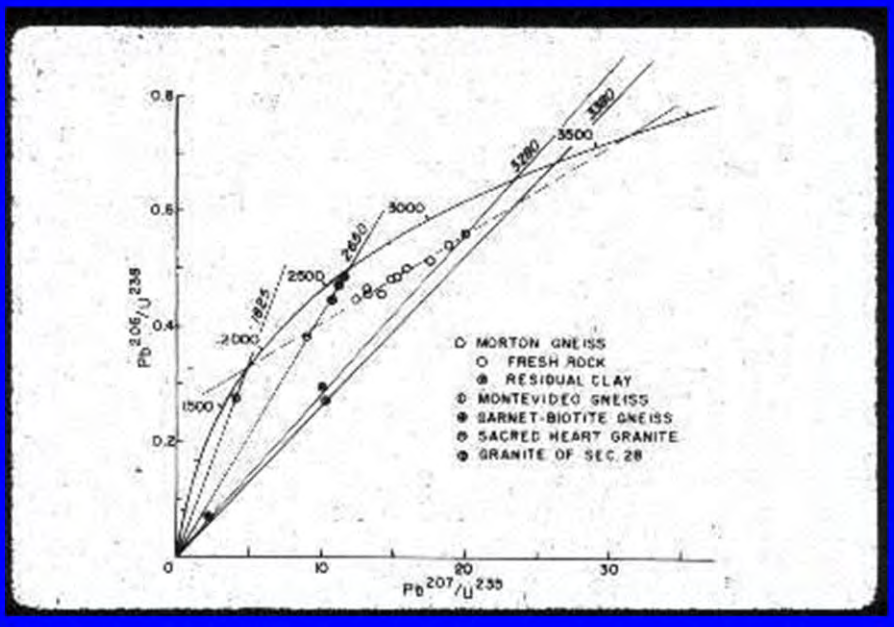
While at the U.S. Geological Survey as Branch Chief for Analytical Mass Spectrometry, Sam worked with the Bureau on its atomic weights program, providing samples of copper, for instance, and workers. His attention to geologic detail (Shields, W. R., Goldich, S. S., Garner, E. L., Murphy, T. J, Natural variations on the abundance ratio and the atomic weight of copper, (Journal of Geophysical Research, 70 (2), p. 479-491, 1965) conclusively demonstrated that the commercially available copper has an atomic weight of 63.54555, with geologic variation of --9.0 to 3.3 per mil depending on the oxidation state and mode of occurrence of the copper minerals**.** The Bureau of Standards, at that time, ran samples for Sam to clean up the flight tube because of its high thermal ionization temperature. Sam also helped the Bureau on the redetermination of the absolute atomic abundance of Rb-85 and Rb-87, necessary for precise Rb/Sr age determinations.

Formation of Iron-rich Rock

- With Henry Lepp
- Multiple oxidation states of iron
- Weathering transport to separate iron from aluminum from rock

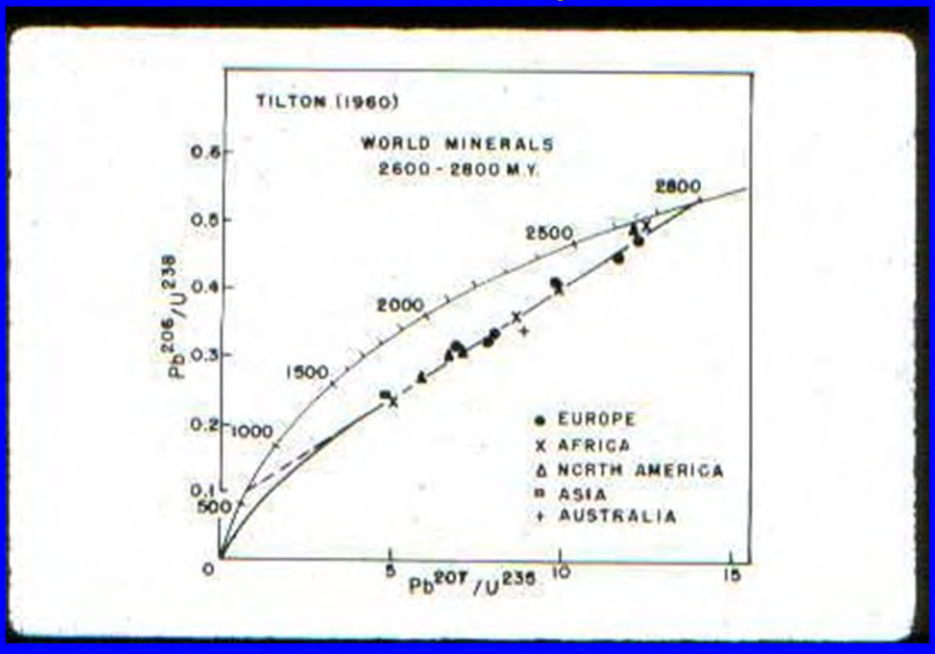
Sam was intrigued with the formation of iron deposits. He brought his understanding of laterite formation, the recognition that iron has multiple oxidation states, and that as reduced iron, there is a geochemical mechanism to separate iron from aluminum in the formation of laterite (Lepp, H., Goldich, S.. S., The chemistry and origin of iron formations, Economic Geology and the Bulletin of the Society of Economic Geologists, 54 (7), p. 1348-1349, 1959). Under reduced oxygen, iron occurs in the +2 valence state, and thus moves in geochemical systems independently from Al+3 and Fe+3. A corollary of the Lepp-Goldich model is that uranium, which also has multiple oxidation states, in its oxidized state is the more mobile, This, coupled with John Gruner's work on roll-front deposits, provide solid foundation for a low oxygen atmosphere in the Precambrian until the late Middle Proterozoic.

Minnesota River Valley



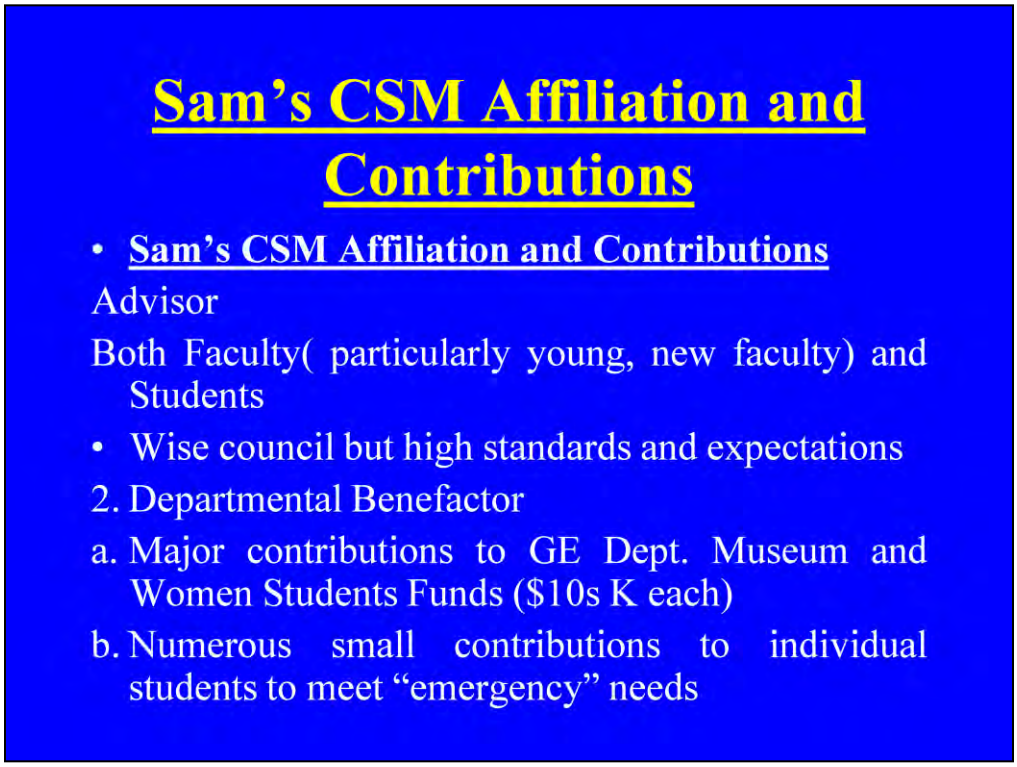
Sam returned to the Minnesota River Valley in the 1950s supervising petrology dissertations. While at the U.S. Geological Survey he initiated work with Ed Catanzaro and Tom Stern and established that the Morton Gneiss was among the oldest rocks on earth (so Sam it WAS the OLDEST!). The dischoncordia age on this diagram is at least 3.3 billion years…old but younger by about 1.0 billion years than some rock in Australia.

Dilatancy



Sam was never in agreement that continuous diffusion was a viable explation for discordance in zircon. He always through that episodic lead loss (including modern lead loss) was the only mechanism to explain the data. In 1969 Sam and Michael Mudrey proposed dilatancy as an explanation for George Tilton's analysis of old zircon ages. Dilatancy argues that the lower intercept on U-Pb diagrams is real and interpretable rather than an artifact of diffusion. Sam felt that the lower intercept in the Lake Superior region represented Paleozoic uplift and erosion with the consequent loss of lead as the rock dilated with uplift.

Sam pursued this at Colorado Schools of Mines by helping to develop the air abrasion technique for zircon analysis. In this technique, soft, discordant zircons are abraded away, whereas the harder, less discordant and presumable older part of the zircon population survives to be analyzed. He would argue that the soft zircon suffered a dilatant or episodic lead loss because of radiation damage. The remaining zircon population does not show any diffusion loss, and provides information for the older undisturbed age of rock.…



Sam spent his last years in Golden, Colorado at the Colorado School of Mines. Graham Cloos provided a short summary of the impact that Sam made at CSM. This impact there is no different that the impact he made at Minneapolis, Stony Brook, DeKalb. He was an advisor not only to his student, but also to his younger colleagues. Sam always considered his students as younger colleagues, and treated them the same.

Sam was a quiet benefactor to many organizations…for those that remember, he was the one anonymous donor to the American Geological Institute for many years. At CSM he gave willingly to women and other minorities, and quietly (and many of us know this from personal experience) helped his students financially and professionally.

Goldich Award Selection Guidelines

- The medal shall be awarded annually by the ILSG Board of Directors to a geologist whose name is associated with a substantial interest in, and contribution to, the geology of the Lake Superior region.

- Nominees are to be evaluated on the basis of their contributions to Lake Superior geology including:
  - a) importance of relevant publications;
  - b) promotion of discovery and utilization of natural resources;
  - c) contributions to understanding of the natural history and environment of the region;
  - d) generation of new ideas and concepts; and
  - e) contributions to the training and education of geoscientists and the public.

It is these qualities that Sam sought and that have incorporated into the guidelines for the Goldich Award.

Prepared by former students and colleagues of Sam Goldich.


Institute on Lake Superior Geology
at its annual meeting
presents this citation to
in recognition of his outstanding contributions as a teacher
and for his leadership in the application and interpretation of
isotopic methods to the understanding of the geology of
the Lake Superior region.
Presented at Duluth, Minnesota
May, 1979

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