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August 21-25, 1978 Snowmass — at Aspen Colorado

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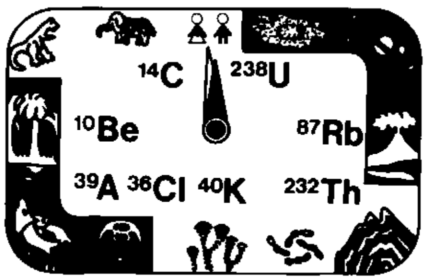

Fourth International Geochronology, Cosmochronology and Isotope Geology Conference

August 21-25, 1978
Snowmass—at Aspen Colorado

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Judging by the number of isotope geo- and cosmochemists that gathered in Snowmass this summer the discipline is active and prospering. The assembled group was a Who's-Who of isotope studies. Although there were a few-well-known scientists missing it seemed as if virtually all associated with the subject during its explosive post-World War II development were present. An interesting mental recreation was to identify the successive generations of scientists and their intertwining associations. Relatively few research centers, starting from the early 1950s or even before, have spread their influence through students and visitors over the entire discipline. The discernable geneology of this science, dependent in general on expensive equipment, makes strong argument for support of centers of excellence. Spontaneous success for isolated and underfunded individuals is exceedingly rare.

Current size and activity do not exist without uncertainty for the future. Employment opportunities of students are limited by decline of research funding and nearly static population of well equipped laboratories. One concern of many participants was precipitous curtailment of funding for research on extraterrestrial materials. The space program has contributed new technology and materials for study, and ideas and observations that occupy a large number of isotope geochemists. Less money will not only hurt their own efforts to answer fundamental questions but will send shock waves through the entire science as competition for funding will increase across the field and displaced scientists will seek jobs where their special training and skills are applicable. Isotope science is in no danger of disappearing but will have to exist in a world of unfulfilled expectations and limited growth. The greatest opportunities probably lie in countries just beginning to afford isotope research in geological development programs.

A notable and welcome newcomer on the international scene is the People's Republic of China. Since the last international meeting they have appeared as visitors to numerous isotope labs in western countries and have hosted visiting delegations to isotope laboratories in China. Their presence at the meeting is further evidence of a positive effort to improve communication and gain from western technology and experience. For us it is an opportunity to make our science useful to more of humankind, to learn about parts of the world that were previously isolated, and to have new human energy and ideas contributed to solution of basic scientific problems.

I can't claim that any revolutionary new ideas or syntheses came to light in the papers presented. Much of the evident activity is generation of more data - new age determinations for rocks from here or there, or new measurements of isotopic composition for random samples or suites of rocks. As usual we were treated to many unreadable tables projected on screens in dark and warm rooms (a rather effective sedative), but there were many excellent presentations and one could gradually develop an appreciation as to just where the science stood and how it was progressing.

In the cosmochemical world models for element synthesis and the age of the universe have largely stabilized with a concensus involving the big bang, approximately 14.5 billion years ago, repeated condensation of gas and dust into stars, synthesis of heavy elements in stars, and violent disruption of stars. A degree of bewilderment accompanies the recent discovery of numerous isotopic anomalies of contradictory implications in early high-temperature condensates of a few primitive meteorites. No one appears to have the details of this matter sorted out. It is currently a matter of intense search and speculation - not unlike trying to work out the details of a civilization from a few samples of its garbage. Simple models fail to make useful predictions and this implies a complexity in the accretion of a solar system and immediately preceding nucleosynthesis events that may be unresolvable.

The ages of the solar system, meteorites, lunar rocks, the earth and terrestrial rocks are now established by a variety of techniques, many quite independent of one another. The controversies that remain warm are largely related to resolving small time differences long ago - the generalized observations seem quite stable and represent facts for genetic speculations.

In the field of heavy isotope radiogenic tracers the new topic was neodymium isotope variations in nature. By now a large variety of igneous rocks in different tectonic settings have been analysed and evolutionary models are being offered for testing. The Nd picture seems largely complimentary to the previously established Sr story - a deficiency in radiogenic Sr being closely associated with excess radiogenic Nd and vice versa. Sm-Nd does seem more resistant to disturbance by surfical geologic agents and metamorphism than Rb-Sr so that rocks undatable by the latter technique may be well dated by those labs equipped to do rare earth work.

The analytical precision demanded for Nd research is greater than for Sr so fewer labs can participate at present. There is a notable deficiency in Nd isotope data for crustal reservoirs - sediments, metamorphic, and basement rocks so that development of comprehensive models of global isotope evolution are hindered. No complete integration of heavy-isotope tracer evolution has been offered but the subject is progressing rapidly.

Pb and Sr isotope evolution models have not been in a state of flux in recent years. The meeting saw several contributions of new data, making the world sampling more complete, but not significantly modifying the overall texture of the earth's isotope complexion. Some finer structure and unique situations, such as ^{207}Pb-rich lead ores in South Africa, were brought out.

Underlying most discussions was the conviction of a present-day heterogeneous crust and mantle. Whether such heterogeneity existed in the Archean, and thereafter, was argued both pro and con, with no general consensus. Nd/Sm appears to have been uniform in the past but the data are insensitive to small variations. Sr isotope initial ratios show great scatter but large uncertainties (mostly due to alteration and dispersion of ratios by geologic prcesses) prevent proof of heterogeneity of homogeneity in Archean time at high confidence levels Advocates of opposing positions each see evidence for their views in the data Most suggestive of persistent heterogeneity is real scatter in Pb isotope data, regardless of geologic age. Much of the Pb scatter can be related to tectonic setting and geographic region. For the coupled U-Pb systems new transformations and projections of isotope data were suggested. Each has their usefulness but none are likely to sweep away popular plots now in use.

Models of the primitive earth are in general accord that conditions within the interior were hot and dynamic, with early establishment of metallic core and silicate mantle. Intense bombardment by large meteorites until about 3.9 billion years ago is another conclusion forced on earth history by comparative planetology, although no certain relicts of this process have been found on earth. Between the constraints of a hot origin, early core, and bombardment, and the fact of earliest Archean rocks is a void filled by speculation that was only rarely addressed in the meeting.

Fission track dating has gained considerable respectability over the past decade as it has proven to give reproducable results and yield some uniquely useful dates By dealing with single crystals on a microscopic scale problems of detrital contamination can be recognized and avoided; resistant minerals such as zircon can survive low-grade metamorphic alteration that affects other components of ash layers Consequently ash dating by fission tracks is providing time benchmarks in rocks ranging in age from Quaternary to Ordovician. Annealing of tracks is a subject for study and controversy itself, but the annealing temperatures of several minerals are well enough defined - by time dependent experiment and studies of deep drill hole samples - to enable fission track dates to provide cooling history details that are supplementary and complementary to information given by conventional isotopic dating techniques. Cooling history studies are an expanding field that interfaces with tectonic-geomorphic analyses, heat production and flux measurements, and geophysical modeling.

On the technological side the impact of the ion probe is beginning to be felt, but mass spectroscopists are not frigtened. While the probe can pinpoint isotope anomalies in minute and precious samples, such as ^{26}Mg in A1-rich particles in the Allende meteorite, it cannot achieve the accuracy, precision, and freedom from interference that is the state of the art with mass spectrometers. The attendant expense, complexity, and calibration difficulties of the probe will keep it out of direct competition with routine mass spectrometric work. Only a few select laboratories will have the responsibility for development and application of this new technology The rest of us will keep busy with more conventional instrumentation providing information of use to others, and to satisfy our own endless curiosity.

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