Grantee:
State University of New York, Stony Brook

Department of Geosciences

Stony Brook, NY 11794-2100

Grant:
DE-FG02-94ER14449

Title:
High Precision Radiometric Dating of Sedimentary Materials

Persons in Charge:
G.N. Hanson (631-632-7210; Fax 631-632-8240; E-mail gilbert.hanson@sunysb.edu) and W.J. Meyers

Objectives:
To develop field, petrographic and geochemical criteria to allow high precision U-Pb dating of sedimentary minerals within rapidly deposited sequences of carbonate and clastic rocks

Results:
Our original goal was to obtain radiometric ages for biostratigraphically controlled syn-sedimentary material with uncertainties of three million years or less to precisely date the times of sedimentation. We have shown that it is possible in some circumstances to obtain uncertainties of 1 Ma or less. Our focus has been on areas of rapid sedimentation from marine and terrestrial records where the duration of formation of the syn-sedimentary minerals is smaller than the age uncertainty. We have published high precision U-Pb ages for calcite in paleosols (caliche), in marine limestones and within siliciclastic fluvial facies. We have also been able to date calcite (altered from aragonite) that formed within an evaporite sequence, and as open marine cements. Additionally, a variety of lacustrine (lake) limestones have provided high precision ages.

In order to get high precision ages it is necessary to have relatively high U/Pb ratios. In most cases this requires enrichment of the samples in uranium. In order to increase the probability of
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obtaining samples enriched in U for dating, we have sought to understand how U is fixed in dated minerals from different environments. For example, a caliche sample, dated at 298 +/- 1 Ma is highly enriched in organic material. The presence of organic material suggests that the sample formed under reducing conditions. Other lines of evidence for reducing conditions include pyrite lining fossil roots and bright orange luminescence indicating incorporation of Mn(II) in the calcite. XANES data indicate that U(VI) the oxidized species is dominant.

Conversely, a sequence of lacustrine carbonates with ages from 15.28 +/- 0.29 to 16.25 +/- 0.22 Ma are without obvious organic matter but have elevated U abundances (100's of ppm). However, the U consists of the reduced species of U(IV). These samples formed at a lake margin, which presumably was at least suboxic. By working to determine how U is incorporated in precisely dated samples we are able to make significant contributions to understanding the conditions that might immobilize and enrich U on geologic timescales. These studies are highly relevant to geochronology and to issues of nuclear waste management.

Key Words

Uranium, U/Pb dating, radiometric ages, carbonates, XANES, biostratigraphically controlled, sedimentary record

Publications


Becker M.L., Cole J.M., Rasbury E.T., Pedone, V.A., Montañez, I.P., and Hanson G.N. Cyclic variations of uranium concentrations and oxygen isotopes in tufa from the middle Miocene Barstow Formation, Mojave Desert, California, Geology 29, 139-142 (2001)


