HGS LUNCHEON MEETING

APATITE FISSION TRACK ANALYSIS APPLIED TO THE MARGINS OF THE GULF COAST BASIN

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Social Period, 11:30 a.m., Luncheon and Meeting, 12:00 p.m.
The Houston Club

Trace quantities of radioactive uranium occur in apatite grains. When one of these uranium nuclei decays by nuclear fission, the two resultant nuclear fragments repel each other and tear a damage trail through their host apatite crystal lattice. Damage trails of this type are called fission tracks, and they can be made visible using conventional light microscopes by immersion in acid solution. The measurable characteristics of the fission tracks in apatite (i.e., their number, length, width) contain a wealth of information regarding the thermal history that the host rock has experienced during its geological evolution.

Apatite fission track ages from 12 Precambrian granitic samples from the Llano Uplift vary from 182±50 Ma to 425±72 Ma (95% confidence intervals), with mean track lengths varying from 11.2±0.1 µm for the same samples. While not systematic, ages generally increase from east to west. Zircons from these samples are metamict, indicating that rocks presently exposed in the Llano Uplift did not experience temperatures greater than ~225±25°C since Precambrian time. A single sample from a Pennsylvanian sandstone (Smithwick Formation), located just east of the Llano Uplift, gives an apatite fission track age of 241±18 Ma, and a mean length of 11.9±0.2 µm. Using available stratigraphic constraints, it is inferred that the Llano basement samples were at temperatures of <70°C prior to initiation of the Ouachita orogeny during Pennsylvanian time. Subsequent heating of the Llano basement samples associated with the Ouachita orogeny is evident in the apatite fission track data. The ages and track length distributions are all consistent with the Llano basement samples having been heated to temperatures of ~90-120°C due to burial of the Llano by a 1-2 km thick Pennsylvanian to Permian molasse sequence (Strawn to Cisco Groups) derived from the Ouachita orogeny. Based on numerical modeling of the apatite fission track data, we interpret the variability in ages and mean track lengths to reflect small magnitude (<1 km) differential loading of the Llano Uplift due to westward thinning of this molasse sequence. From late Permian (?) through Jurassic time, samples cooled from ~90-120°C, based on model results, to <40°C, based on stratigraphic constraints. This early Mesozoic stage of cooling is attributed to erosional unroofing associated with extensional collapse of the Ouachita orogen during initial opening of the Gulf of Mexico. Mild reheating of these samples to >60°C due to deposition of ~1 km of Cretaceous to Early Tertiary (?) strata across the Llano region is needed to explain the low percentage of tracks in the 14-16 µm range. Final cooling of these samples below ~60°C did not occur until post-Paleogene (?) time. This late stage cooling is interpreted in terms of regional Tertiary erosion along the outer rim of the Gulf of Mexico basin due to flexural upwarping associated with basinward loading of the crust.

RAY DONELICK - Biographical Sketch

R. A. (Ray) Donelick started Donelick Analytical in 1991 in order to provide fission-track related services to the energy industry. In addition to his being a sole proprietor, Ray is currently an Adjunct Assistant Professor at Rice University and a Research Scientist at The University of Texas at Austin. Ray received his Bachelor of Science degree in Geology from the University of Miami in 1983 and his Masters and Doctoral degrees in Geology from Rensselaer Polytechnic Institute in 1986 and 1988 respectively. He continues to focus his research efforts toward the development of improved techniques for the application of apatite fission track analysis to the study of geological problems.