Application of apatite fission track analysis to hydrocarbon research in the Atlantic Provinces

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Apatite fission track analysis is a rock-dating technique that also provides the temperature attained by the rocks in the geological past. The technique is particularly sensitive and well-calibrated in the temperature range 60 to 120°C, which coincides with the range of temperatures at which liquid petroleum is generated in organic-rich sedimentary rocks, migrates and (under the right conditions) accumulates to form reservoirs. The technique exploits the instability of fission tracks (damage trails) in the crystalline lattice of the mineral apatite [$Ca_5(PO_4)_3(F,Cl,OH)$], which occurs commonly among sand grains. Fission tracks are formed continuously through time from the spontaneous radioactive decay of ^{238}U, present in minute amounts in the structure of apatite. The number of tracks per unit area is a function of the uranium content, and of the time elapsed since the rocks cooled below about 120°C, and thus an age is obtained. But tracks (formed with a length of 16μm) are annealed (fade) as a function of time and temperature and following the laws of diffusion, therefore the measurement of the lengths of tracks within the mineral grain allow an assessment of the timing, magnitude, and style of cooling for rock samples that were hotter in the past. The development of predictive modelling techniques and fast computers have transformed apatite fission track analysis into a powerful tool in the study of the thermal history of sedimentary basins. Dalhousie's Fission Track Laboratory has recently been awarded an equipment grant from the Canada-Nova Scotia Offshore Development Fund, thanks to which the region has now this world class facility unique in Canada. Highly trained personnel, students and scientists and industry geologists from Canada and several other countries benefit from the research carried out in the lab.

Fission track analysis in the Maritimes Basin (located beneath the Gulf of St. Lawrence and adjacent low-lying areas of New Brunswick, Nova Scotia, Prince Edward Island and Newfoundland), confirm that sedimentary rocks were heated to temperatures in excess of 100 to 150°C very soon after their deposition in the Carboniferous Period, probably leading to hydrocarbon generation and migration, and to the formation of significant coal deposits and coal bed methane. Since the Permian Period the area has been uplifted and up to 4 km of sedimentary cover has been removed by erosion from most of the Canadian margin.

Studies in the Scotian Basin offshore Nova Scotia, where

25 exploratory wells have dicovered hydrocarbons, show that samples from the Missisauga, Mic Mac and Verrill Canyon Formations of early Cretaceous age have apatite fission track ages younger than their stratigraphic ages, indicating partial to total annealing of fission tracks. The computer modelling of data for many samples indicates that some of the rocks have been hotter (up to 55°C) in the past (at some time between 100 and 40 million years ago) than at present.