Fluorine-rich ferroan calcite and diagenetic zircon in the Newburn H-23 well, Scotian Basin, Canada: indicators of unusual diagenetic processes*

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Diagenetic minerals preserve an important record of fluid flow in the development of hydrocarbon basins. Previous studies in the Scotian Basin have shown the importance of hot brines transporting hydrocarbons and precipitating unusual suite of late diagenetic minerals. The Newburn H-23 on the Scotian Slope has two diagenetic mineral occurrences which have not been documented elsewhere in the Scotian Basin: fluorine-rich ferroan calcite (F-Fe-calcite) and diagenetic zircon.

Fe-calcite contains fluorine >1 wt% in several samples. Fluoride (F^-) in diagenetic environments has been accredited to a variety of processes including the advection of hydrothermal fluids through sediments, Al-silicate reactions, degradation of sea grass, and carbonate mineral diagenesis. Fluids with low pH and F concentrations >10 ppm are required. Fluoride ions have been shown to be removed from solution in these environments as a result of: (a) adsorption onto the surface of calcite and (b) precipitation of fluorite on the surface of the calcite. The F-Fe-calcite in this study is most common in the deepest studied samples at 5.4 km, late in their paragenesis and is associated with formation of secondary porosity, fibrous chlorite lining secondary porosity and late siderite. Grains of F-Fe-calcite also shows patchy fluorite precipitation. These observations suggest that the depth probably influenced either a) the availability of fluoride or the mechanism of association of fluoride with Fe-calcite, or b) changes in the composition of circulating basinal fluids.

Zircon grains in this well display features which suggest that they are not purely detrital, including crystal outlines which are straight adjacent to pores, partially lobate, appearing to fill porosity, and cross cutting detrital and other diagenetic grains. Diagenetic zircon has been documented to form new crystals at temperatures ~270°C and outgrowths around detrital zircon at ~250°C, with zirconium mobilized during the alteration of detrital zircons under low-grade metamorphic conditions. The presence of diagenetic sphalerite and the documented mid Cretaceous thermal event in the Scotian Basin indicate conditions which could have been suitable for the formation of diagenetic zircon in this well. The euhedral form of these grains thus may suggest (a) a large supply of complexing elements including fluorine in parent circulating solutions which formed the zircon, (b) a large supply of zirconium from altered and dissolved metamict detrital zircon, (c) temperatures at least of the order of ~250°C which persisted long enough for <200 µm euhedral crystals to form.

Winner of the AGS Rupert MacNeill Award for best undergraduate student oral presentation

Atlantic Geology, 2016, Volume 52
Atlantic Geoscience Society Abstracts 42nd Annual Colloquium & General Meeting 2016
doi: 10.4138/atlgeol.2016.004