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Diagenetic F-rich ferroan calcite and zircon in the offshore Scotian Basin, eastern Canada: Significance for understanding thermal evolution of the basin

Georgia Pe-Piper[1,*], Christopher Sangster[1], and Yuanyuan Zhang[1,†]

[1]Department of Geology, Saint Mary's University, Halifax, Nova Scotia B3H 3C3, Canada

Abstract

In the Scotian Basin, offshore eastern Canada, an unusual combination of high heat flow in the Cretaceous and the abundance of halite has resulted in unusual diagenetic minerals such as sphalerite. The Newburn H-23 well is the most distal well in the basin with good core samples and has two previously unknown diagenetic mineral occurrences: fluorine-rich ferroan calcite and diagenetic zircon. This study uses SEM backscattered electron images and EDS analyses, EMP WDS mineral analyses and Raman spectroscopy to determine mineral chemistry and textures to investigate the diagenetic and thermal significance of these minerals.

Late diagenetic Fe-calcite contains 1–2.5 wt% fluorine, mostly from adsorption, but rarely as small fluorite crystals. Fluoride is also adsorbed on the surfaces of some framework minerals and chlorite. Fluoride was transported in highly saline formation brines derived from the Argo salt Formation. Zircon grains, 20–40 μm in size, have crystal outlines that are straight adjacent to pores, partially lobate filling porosity, and cross cutting other grains: these may be diagenetic. Some zoned detrital zircon grains show 1–3 μm wide diagenetic outgrowths. Neoformation of diagenetic zircon requires temperatures of >250 °C. Transport of zirconium is favored by ligands in low-pH solution, principally fluoride and phosphate anions, with zirconium mobilized during the alteration of metamict detrital zircon under low-grade metamorphic conditions. The presence of diagenetic sphalerite and the documented mid-Cretaceous thermal event in the Scotian Basin indicate conditions that could have been suitable for the formation of diagenetic zircon in this well. Suitable geological conditions for such diagenetic formation of zircon will be found in a subsiding rift basin with early evaporites that are affected by a subsequent phase of volcanism due to new rifting or subduction.

Keywords: Diagenesis, zircon, ferroan calcite, fluorine, Scotian Basin