Diagenetic barite and sphalerite in middle Mesozoic sandstones, Scotian Basin, as tracers for basin hydrology

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Cementation of sandstone by minor late barite and sphalerite is widespread in the Scotian Basin at burial depths >2 km, providing information on fluid flow in the basin. The texture and geochemistry of these minerals was analysed by scanning electron microscopy and electron microprobe on samples from conventional core. Barite and sphalerite post- date silica and carbonate cementation, occurring in veins or occupying secondary porosity. They occur with diagenetic chlorite, kaolinite, pyrite, titania minerals, kutnohorite, and Mn-siderite. This study relates barite and sphalerite to the salt-tectonic evolution of the basin, based on previous seismic interpretation, and the thermal history of the basin, based on previous fluid inclusion studies. Barite is readily transported in basinal fluids >100 °C, yet is consistently a very late diagenetic mineral, implying that the source of Ba is due to late diagenetic breakdown of K-feldspars at 2–3 km depth, confirmed by co-variation of Ba and Rb in sandstones. Sulphur isotope data suggest that the SO_4^{2+} was derived from Argo Formation evaporites which include 1–7% anhydrite. The abundance of diagenetic barite in the eastern Scotian Basin reflects the abundance of feldspar supplied to this area. Sphalerite transport takes place only at temperatures >140 °C and salinities of at least 10 % NaCl. Zn is most abundant in Lower Cretaceous sandstones with important supply of Fe-Ti oxides from Labrador, and is less abundant in all mudstones, limestones, and in Jurassic sandstones. Sphalerite thus requires dissolution of Fe-Ti oxides during passage of saline formation waters through sandstone pathways. Active detachment faults on salt welds provide both pathways and a source of salt for such formation water. The particularities of source and transport of both barite and sphalerite allow the pathways of basinal fluids and their relationship to active salt tectonics to be inferred, providing indirect dating of the later stages of diagenetic paragenesis corresponding to times of hydrocarbon charge. For example, sphalerite distribution and fluid inclusions show that hot saline fluids are related to late Cretaceous– Paleogene movement on the Banquereau detachment, long after the regional Aptian-Albian high heat flow event. Such fluids contributed to the apatite fission-track signature in the basin. This study shows how small amounts of late barite and sphalerite cement provide important constraints in understanding fluid flow in the Scotian Basin, a technique that should be applicable to other basins with complex salt tectonics.

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