Hoodoo Dome, Ellef Ringnes Island: Implications for Hydrocarbon Exploration in Canada's High Arctic

A.C Springer*, University of Calgary, Calgary, Alberta
springerac1@gmail.com
and
B. Guest, University of Calgary, Calgary, Alberta
and
K. Dewing, Geological Survey Canada - Calgary, Calgary, Alberta

Abstract

Over one hundred evaporite diapirs, cored by Carboniferous Otto Fiord Fm., reside along the Sverdrup Basin's axis in the Canadian High Arctic. However, due to the remoteness of this region their tectonic evolution and hydrocarbon potential remain poorly understood. This study focuses on one of the better known diapirs, Hoodoo Dome, located on Ellef Ringnes Island. We use ground-based geological mapping as well as (U-Th)/He thermochronology to better understand the thermal evolution of the rocks around the dome and tectonic influences on salt migration. Our goal is to improve the understanding of thermal histories and hydrocarbon potential of the salt structures in the Sverdrup Basin.

The Sverdrup Basin is a steep sided pericratonic trough estimated to contain approximately thirteen kilometers of Carboniferous to Tertiary strata. At Hoodoo Dome, sandstone samples from the Early Cretaceous Isachsen Fm. and Late Cretaceous Hassle Fm. were collected at Hoodoo Dome for apatite and zircon (U-Th)/He thermochronology, a fairly new low temperature thermochronometric technique that yields cooling ages marking a sample's passage through the ~ 70°C (apatite) and ~175-193°C (zircon) isothermal surfaces. Samples were collected along 2 transects (north-south and east-west) across Hoodoo Dome, where seven samples yielded sufficient apatite grains and ten samples yielded sufficient zircon grains. The apatite sample suite exhibits a large distribution of apatite helium (AHe) ages, both reset and non-rest. Only 2 samples, BG 14-35-2 and BG 14-34-4 are interpreted as completely reset. Sample BG 14-35-2, the stratigraphically oldest sample, yielded a mean AHe age of 59.2 ±3.9 Ma, whereas sample BG 14-34-4, approx. 150m up section from BG 14-35-2 yielded a mean AHe age of 69.4 ±4.2 Ma. These reset ages suggest that dome uplifting was active by ≈70 Ma at the latest and continued until at least ≈60 Ma, consistent with the timing the Eurekan Orogeny. The remaining AHe ages from samples collected farther from the dome core and up-section of BG 14-34-4 by ≈500m-1300m exhibit both reset and non-reset AHe ages ranging from ≈41.3 Ma-1670 Ma. These data suggest long-term residence in the Partial retention zone (PRZ) where grains have experienced partial He loss at shallow depths (<2km). Zircon helium (ZHe) ages from the two transects, yielded a broad distribution of pre depositional ages of 157.9 Ma-2417.5 Ma. These ages are likely zircon source exhumation ages and compliment the shallow burial interpretation of the AHe data.

This study complements recent studies conducted using legacy seismic and well log back-stripping across Hoodoo Dome which were used to qualitatively answer questions regarding the rate, mechanism, and regional influence of diapirism during the Dome's development. Our results add new quantitative data regarding the ascent of the evaporite core as well as thermal histories for the rocks surrounding Hoodoo Dome. Finally, we hypothesize that salt cored structures elsewhere in the Sverdrup Basin will exhibit similar thermal history patterns, interpreted here as indicating compression induced salt extrusion in the Latest Cretaceous at the onset of the Eurekan Orogeny.