EGU General Assembly 2021

EGU21-3135
https://doi.org/10.5194/egusphere-egu21-3135
EGU General Assembly 2021

Resolving thermal histories via multi-kinetic apatite fission track data: A case study from Phanerozoic strata within the Peel Plateau NWT, Canada

Jennifer Spalding[1], Jeremy Powell[2], David Schneider[1], and Karen Fallas[2]
[1]University of Ottawa, Earth Sciences, Ottawa, Canada (jspaldin@uottawa.ca)
[2]Natural Resources Canada, Geological Survey of Canada

Resolving the thermal history of sedimentary basins through geological time is essential when evaluating the maturity of source rocks within petroleum systems. Traditional methods used to estimate maximum burial temperatures in prospective sedimentary basin such as and vitrinite reflectance (%Ro) are unable to constrain the timing and duration of thermal events. In comparison, low-temperature thermochronology methods, such as apatite fission track thermochronology (AFT), can resolve detailed thermal histories within a temperature range corresponding to oil and gas generation. In the Peel Plateau of the Northwest Territories, Canada, Phanerozoic sedimentary strata exhibit oil-stained outcrops, gas seeps, and bitumen occurrences. Presently, the timing of hydrocarbon maturation events are poorly constrained, as a regional unconformity at the base of Cretaceous foreland basin strata indicates that underlying Devonian source rocks may have undergone a burial and unroofing event prior to the Cretaceous. Published organic thermal maturity values from wells within the study area range from 1.59 and 2.46 %Ro for Devonian strata and 0.54 and 1.83 %Ro within Lower Cretaceous strata. Herein, we have resolved the thermal history of the Peel Plateau through multi-kinetic AFT thermochronology. Three samples from Upper Devonian, Lower Cretaceous and Upper Cretaceous strata have pooled AFT ages of 61.0 ± 5.1 Ma, 59.5 ± 5.2 and 101.6 ± 6.7 Ma, respectively, and corresponding U-Pb ages of 497.4 ± 17.5 Ma (MSWD: 7.4), 353.5 ± 13.5 Ma (MSWD: 3.1) and 261.2 ± 8.5 Ma (MSWD: 5.9). All AFT data fail the χ^2 test, suggesting AFT ages do not comprise a single statistically significant population, whereas U-Pb ages reflect the pre-depositional history of the samples and are likely from various provenances. Apatite chemistry is known to control the temperature and rates at which fission tracks undergo thermal annealing. The r_{mro} parameter uses grain specific chemistry to predict apatite's kinetic behaviour and is used to identify kinetic populations within samples. Grain chemistry was measured via electron microprobe analysis to derive r_{mro} values and each sample was separated into two kinetic populations that pass the χ^2 test: a less retentive population with ages ranging from 49.3 ± 9.3 Ma to 36.4 ± 4.7 Ma, and a more retentive population with ages ranging from 157.7 ± 19 Ma to 103.3 ± 11.8 Ma, with r_{mr0} benchmarks ranging from 0.79 and 0.82. Thermal history models reveal Devonian strata reached maximum burial temperatures (~165°C-185°C) prior to late Paleozoic to Mesozoic unroofing, and reheated to lower temperatures (~75°C-110°C) in the Late Cretaceous to Paleogene. Both Cretaceous samples record maximum burial temperatures (75°C-95°C) also during the Late Cretaceous to Paleogene. These new data indicate that Devonian source rocks matured prior to deposition of Cretaceous strata and that subsequent burial and heating during the Cretaceous to Paleogene was limited to the low-temperature threshold of the oil window. Integrating multi-kinetic AFT data with traditional methods in petroleum geosciences can help unravel complex thermal histories of sedimentary basins. Applying these methods elsewhere can improve the characterisation of petroleum systems.