

A Workflow for Routine Application of Apatite Fission Track Analysis in Petroleum Systems Analysis and Modeling Exemplified in the Hammerfest Basin, Southern Norwegian Barents Sea

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The knowledge about the temperature and timing at which particular petroleum source-rocks mature is fundamental in petroleum systems analysis. This is especially relevant for areas subjected to uplift and erosion. Several established methods such as e.g. vitrinite reflectance analysis are readily applied to determine the maximum burial depth and temperature of maximum maturation of source-rocks.

In contrast the determination of the corresponding timing is often approximated by combining several geological constrains and hence hindered significantly in precision. Independent means on the timing of burial and thermal influence are solely derived by apatite fission track analysis, AFTA. In exploration areas which are characterized by multiple uplift and cooling events, the precise determination of timings of maximum burial and onset of cooling can only be facilitated by rigorous implementation of AFTA results.

The Hammerfest Basin, located in the southern Barents Sea offshore northern Norway, is such an area with a multi-phase cooling history. There, solely an approach considering AFTA results allows for a reasonable precise burial history reconstruction and assessment of thermal regimes that prevailed in the past.

We will demonstrate the exploitation of AFTA results via a semi-automated workflow implementation into our in-house basin modeling software SEMI. We are going to compare results of hydrocarbon maturation and migration simulations employing burial/thermal histories with and without AFTA constrains. Our model results will be discussed with respect to their sensitivity towards a routine usage of AFTA-data within a petroleum system model. We will also focus the discussion on the time uncertainty inherent the AFTA results and its impact on the maturation and migration histories.

Additionally, we will present a workflow setup that enables a more routinely use of AFTA results in petroleum systems analysis. This workflow will incorporate the modeled time estimates of maximum heating and onset of cooling from AFTA t-T path modeling. Maps that shows the lateral distribution of erosion amounts at separate cooling events are derived in order to provide tight quantitative constrains on times of maximum burial and onset of uplift and cooling. With respect to the quantification of erosion during uplift events, this workflow is not restricted to AFTA results and supports the combination with other appropriated methods e.g. erosion estimated from sonic data.