Geophysical Research Abstracts
Vol. 20, EGU2018-13279, 2018
EGU General Assembly 2018
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Uncertainties on amount of erosion from porosity well-log data

Andrea Licciardi (1), Kerry Gallagher (1), Stephen Anthony Clark (2), and Bart Willem Hendrik (2)
(1) Université de Rennes 1, Rennes, France (andrea.licciardi@univ-rennes1.fr), (2) Statoil Research, Trondheim, Norway

Estimating the amount of erosion experienced by a sedimentary basin during its geological history plays a key role in basin modeling. In particular, thermal and maturation histories of the sediments can be strongly affected by erosional events.
Under certain assumptions concerning compaction, porosity data from well logs can provide constraints on the amount of net erosion experienced by sediments since the time of maximum burial. As the sediments are buried deeper, mechanical compaction induces a reduction in their total porosity. If no erosion occurs, porosity reduction with depth can be approximated with an exponential law with lithology-dependent parameters (background porosity curve). As compaction is irreversible, if the basin undergoes uplift and erosion, the uplifted rocks will retain their minimum porosity but will be located at shallower depths relative to the inferred background porosity-depth relationship. However, simply by shifting the background curve to fit the measured porosity values in the borehole, an estimate of the amount of erosion can be obtained.
This relatively simple approach is routinely used to estimate net erosion in uplifted basins and to constrain thermal histories of the sediments. In the majority of applications, however, the parameters of the exponential porosity-depth function (i.e. porosity at the surface and compaction coefficient) for any given lithology are assumed to be known exactly either from laboratory or well log measurements or from empirical estimates in nearby areas. In addition, the solution is often expressed by a single optimal value for the amount of erosion with no associated uncertainties.
In this study, we present a novel methodology that allows the propagation of uncertainties in the compaction parameters to uncertainties in the retrieved amount of erosion from a single porosity well-log. We use a Markov Chain Monte Carlo algorithm to estimate the posterior distribution for the amount of erosion given prior information about the compaction parameters (including correlation between them) for a number of different lithologies. The algorithm is applied to both synthetic data and real data from a well in the Barents Sea.
The probabilistic results of our algorithm can be used to build maps of erosion by combining data from multiple wells as well as to better constrain the inversion of thermal indicator data (fission track, vitrinite reflectance, etc..) for thermal history modeling.