



The University of Adelaide
Department of Geology and Geophysics

QUANTIFICATION OF EXHUMATION IN THE COOPER-EROMANGA BASINS, AUSTRALIA

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ABSTRACT

Exhumation in the Cooper-Eromanga Basins of South Australia and Queensland has been quantified using the compaction methodology. The standard method of estimating exhumation based on the degree of overcompaction of a single shale unit has been modified, and twelve units, predominantly shales ranging in age from Cretaceous to Permian have been analysed, and the results from different units crossplotted. Furthermore, not only sonic log data, but also data from the other porosity logs (density and neutron) and the adjusted sonic log have been used to quantify exhumation. However, values from the sonic log data are considered the most reliable.

The results of the compaction analysis reveal that Late Cretaceous - Tertiary exhumation increases eastwards from the Patchawarra Trough, through the Gidgealpa-Merrimelia-Innamincka Trend and Nappamerri Trough into the Queensland sector of the basins. Maxima of approximately 1 km of Late Cretaceous - Tertiary exhumation occur north of the Jackson-Naccowlah area and near the north-eastern boundary of South Australia in the Morney and Curalle domes. In many wells the Permo-Triassic section of the Cooper Basin is more overcompacted than the Mesozoic section of the overlying Eromanga Basin. In such areas maximum burial-depth of the Cooper Basin sequence is believed to have been attained in Late Triassic - Early Jurassic times, prior to the deposition of the Eromanga Basin, and not to have been subsequently re-attained.

Vitrinite reflectance data were also modelled in order to investigate exhumation in the Cooper-Eromanga Basins. However, without independent information on the thermal history of the area, vitrinite reflectance data cannot uniquely reveal exhumation magnitudes, because any excess of reflectance above that consistent with current temperatures can be explored by a combination of higher palaeogeothermal gradients and/or exhumation from greater burial-depth. Nonetheless, vitrinite reflectance data do seem to require a relatively recent increase in geothermal gradients in the basins, and higher geothermal gradients during the deposition of the Cooper Basin sequence. Exhumation magnitudes indicated by such a geothermal gradient history are largely consistent with those derived from the compaction methodology.

Exhumation results based on apatite fission track analysis and fluid inclusion homogenization temperatures have also been compiled and although of limited coverage, these results are also broadly consistent with those based on compaction analysis.

Seismic reflection profiles indicate the compressive nature of the structural style associated with the major uplift events in the Cooper-Eromanga Basins. While a number of mechanisms may have driven regional Late Cretaceous - Tertiary exhumation, the two-layer lithospheric compression model is considered as the most complete explanation of uplift.

The study has major implications for hydrocarbon exploration in the basins. Regarding maturation levels, predicted maturation of source rocks will be greater for any given geothermal history if Late Cretaceous - Tertiary exhumation is incorporated in maturation modelling. Perhaps even more importantly, the excess of exhumation of the Cooper Basin sequence over the Eromanga Basin sequence suggests that Cooper Basin source rocks in some areas are unlikely to charge Eromanga Basin reservoirs because hydrocarbons would have been expelled from these source rocks in Late Triassic - Early Jurassic times, prior to the deposition of the Eromanga Basin.

The study has also implications for depth-conversion of seismic two-way-times because it helps quantify the (high) velocity anomalies associated with overcompaction. **Exhumation values from this study can also be used to improve porosity predictions of reservoir units in undrilled targets.**

STATEMENT

This thesis contains no material which has been accepted for the award of any other degree or diploma in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text.

If accepted for the award of the degree and, if applicable, I consent to the thesis being made available for photocopying and loan.

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This thesis, particularly the well log, vitrinite reflectance and AFTA data, and seismic sections are published with the permission of the Santos Ltd. and the Cooper-Eromanga joint venture partners.