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Influence of Jurassic Sill Intrusions on the Organic Matter of Upper Triassic Lacustrine and Fluvial Sediments of North Victoria Land (Antarctica)

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The Beacon Supergroup of North Victoria Land (Antarctica) comprises a Late Triassic to Lower Jurassic succession of siliciclastic and volcaniclastic deposits, which are intruded by mafic sills of Early Jurassic age (Ferrar Group). The sediments contain fluvial channel sandstones as well as lacustrine and palustrine deposits. These sediments have been sampled during the German Antarctic North Victoria Land Expedition IX (2005/2006) for organic geochemical and petrographical analyses in order to better describe the depositional environment and to investigate whether the sill intrusions are responsible for thermal alteration processes of the sedimentary organic matter.

We compare data of three locations with different settings of sill intrusions. At Timber Peak 80 m of sediments are embedded between two 150m thick sills, and an approximately 3.5 m thick section of carbonaceous mudstones and coals, 12 m above the lower sill has been investigated. At Mt. Carson East Lake 17.5 m of sediments, of which an approximately 2.5 m thick section has been investigated, are embedded between two sills. At Anderton Glacier an about 80 m thick sedimentary section, deposited on the granitic basement, is overlain by a sill of at least 350 m thickness. The distances of the samples from the sill at this site vary approximately between 40 and 60 m.

Organic geochemical methods (elemental analyses, RockEval pyrolyses, biomarker investigations) indicate that all sediments contain mixtures between land plant and aquatic organic matter, which in turn suggests that the sediments were likely deposited in swamp-like and/or lacustrine environments.

Vitrinite reflectance data indicate that the sediments at Timber Peak have reached thermal maturities of the oil window. We observe a general increase of vitrinite reflectance (VR) values from the top to the lower parts of the analyzed section. The increase of approximately 0.5 %-VR over a depth interval of 3.5 m is unusual and cannot be explained by subsidence processes, but must be related to an abnormal heat flow related to the sill intrusions. The maturity data suggests that the underlying sill had a greater thermal influence on the sediments than the overlying one. This assumption seems plausible as the vertical distance between the sample positions and the lower sill is 12 m compared to 65 m towards the upper sill. The increase of reflectance values, however, is not uniform and the observed scattering of the data might be attributed to variable thermal conductivities of different sediment types.

At Anderton Glacier, we observe a general increase of vitrinite reflectance values from the lower parts of the analyzed section towards the top. The systematic increase of vitrinite reflectance of approximately 1 %-VR over a depth interval of 21 m can only be explained by an abnormal heat flow related to the overlying sill.

At Mt. Carson East Lake, we observe a general increase of vitrinite reflectance values from the lower parts of the analyzed section towards the top. This systematic increase of approximately 1 %-VR over a depth interval of 2.3 m is probably caused by an abnormal heat flow related to the sill intrusions. The maturity data suggests that the overlying sill had a greater thermal influence on the sediments than the underlying one. This assumption seems plausible as the vertical distances of the sample positions are closer to the lower sill of this site.

The minimum maturities at Timber Peak and Anderton Glacier are equally low (0.4 %-Rr) and therefore likely resemble the background maturity which has been induced through burial of the sediments. If we assume that the Early Jurassic (Kirkpatrick) Lava Flows of the Ferrar Group, which are exposed in North Victoria Land, covered the entire working area, than the sediments experienced a minimum burial of about 1000 m.

However, the local abnormal thermal alterations are induced through the sill intrusions because the thermal

maturities of samples decrease with increasing distance from the next sill within all sections. At Mt. Carson East Lake the samples of the thin sedimentary unit between the two sills have experienced the strongest thermal maturation (2.2 to 3.2 %-Rr). The Timber Peak samples with the highest maturities (0.9 %-Rr) have a much shorter distance to the effective sill (12 m) than the high mature samples at Anderton Glacier (1.2 %-Rr, 40 m). We explain the latter observation through differences in temperature and duration of the thermal influence at the two sites, which in turn could be related to differences in the thickness of the effective sills, which is much smaller at Timber Peak than at Anderton Glacier.

We combined our investigations with inverse kinetic modelling of vitrinite alteration and are able to estimate the temperatures, which have affected the sediments at the different locations.