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Late Variscan tectonothermal history of the Holy Cross Mts. (central Poland) as revealed by integrated palaeomagnetic and 1-D basin modelling study

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Classical outcrops of the Holy Cross Mountains (HCM) in Poland are among a few areas in Central Europe exposing a complete succession of Phanerozoic strata. The long-studied Palaeozoic sections are of a key importance to understand a complex Phanerozoic development in the region bordering the East European Craton from the south-west. The Palaeozoic core of HCM consists of two tectonostratigraphic units: southern (Kielce) and northern (Łysogóry), separated by a Holy Cross Fault. Different organic maturity data (conodont CAI, vitrinite reflectance - VR, biomarkers) consistently indicate an important difference in thermal alteration pattern between the pre-Permian Palaeozoic and the Permian-Mesozoic cover in the Kielce region. In its northern part, adjoining the Holy Cross Fault, the Devonian carbonates are characterized by VR$\geq$0.7 % and CAI 1.5-3.5, while in the south they are less altered thermally, displaying VR$\leq$0.65 % and CAI 1.0-1.5. On the other hand, Permian-Mesozoic cover reveals a uniformly low degree of thermal alteration (VR close to 0.6 % and CAI 1).

Palaeomagnetic studies and thermal modelling were performed in outcrops and borehole sections of the Middle – Upper Devonian carbonates, situated in the areas of contrasting thermal histories. Rocks with a higher degree of thermal alteration revealed presence of secondary, most-probably post-folding magnetization residing in magnetite (component A). The age of this remagnetization might be estimated as Early Permian (ca. 290 – 260 Ma). The remagnetization is absent in the less thermally altered areas, where a pre- or early synfolding magnetization was preserved (component B). As presence of the component A correlates with thermal indexes, it might be concluded that its acquisition was controlled mostly by post-orogenic uplift and cooling. Radiogenic 87Sr/86Sr isotope ratios in carbonates do not coincide with occurrence of component A which means that chemical remagnetization due to influence of deeper basinal and/or juvenile fluids is rather unlikely.

The results of burial-thermal modelling of borehole sections are in a good agreement with palaeomagnetic data. The results from Janczyce I borehole, situated in the northern part of Kielce region, indicate a significant role of elevated Variscan (Early to Late Carboniferous) heat flow, followed by cooling from ca. 130 to 70 degrees Celsius between 330 and 260 Ma. This is consistent with a concept attributing the Early Permian remagnetization to post-Variscan (i.e. Late Carboniferous) uplift and related cooling. The secondary magnetization could have been facilitated by oxidation of pyrite during a circulation of meteoric fluids. The absence of elevated heat flow and ensuing cooling in the southern part of the HCM corresponds to a lack of the Early Permian remagnetization. Our study seems to demonstrate that, under special circumstances, the palaeomagnetic data may represent a useful complementary tool in deciphering tectonothermal dynamics of a sedimentary basin.