data being virtually absent. This fact seriously restrains utility of the Prague Basin as an international standard and complicates interpretation of its development in time and space.

Hence main aims of our study were: (1) to characterize the Sr isotopic composition of Late Silurian to Middle Devonian seawater in this region in order to facilitate correlations with similar sequences abroad, (2) to test whether (when) the studied basins were fully connected with the world ocean reservoir and provide constraints on their sedimentary environment, (3) to apply the Sr isotopic composition for direct dating of sections lacking stratigraphically significant pelagic faunas (e.g., on reefs). As a study material were chosen microdrilled samples of secondary layer of carefully selected, little altered brachiopods, arguably the best available proxies for composition of Palaeozoic seawater (e.g., Veizer et al. 1999 and references therein).

The newly obtained Sr isotopic data for Lochkovian and Early Givetian brachiopods from the Prague Basin behind the Koněprusy reef closely follow the development of the main ocean reservoir. In Pragian to Emsian, however, the data points plot above the seawater curve extrapolated from the extensive reference database of Veizer et al. (1999). This fact, together with high contents of transition metals and anomalous, high $\delta^{18}O$ values in carbonate of the studied brachiopods (Hladíková et al. 2000), indicate that the communication of Prague Basin with the main ocean reservoir had to be limited during a substantial part of Early Devonian. On the other hand, this barrier must have been incomplete, as the exchange of planktonic faunas was not interrupted.

As an analogous trace-element and O isotopic anomaly was not observed in brachiopods from the Pragian sequence of the Koněprusy reef itself, it may be concluded that this reef was exposed to open ocean. Hence Sr isotopic ratios from the exposed side of the reef should mimic those of the main ocean reservoir and should be usable for dating. When our results from apical part of the reef are compared with reference data by Veizer et al. (1999), ratios 0.70840 to 0.70842 indicate Middle Pragian ages corresponding to the *kindlei* Z. (Janoušek et al. 2000). On this basis it seems that the Pragian sedimentation on the Koněprusy ridge was relatively short-lived, reflecting mostly a secondary mid-Pragian sea level rise, with the Upper Pragian carbonate beds being either primarily absent and/or later largely truncated.

Taken together, the easiest explanation of the available stratigraphic and geochemical data is that reef structure at Koněprusy, preserved fragmentarily, originally continued in large oceanic reef chains of atoll shape (Galle et al. 1999) that separated the inner part of the Prague Basin from the main ocean reservoir. Considering a slight and even diminishing content of silt and clay in carbonate deposits of these Pragian–Eifelian times, the anomalously radiogenic compositions of the brachiopods may be due to: (1) retarded development of Sr isotopic composition as a consequence of incomplete homogenization of the detached basin with the main ocean reservoir, (2) deposition of aeolian dust from the Old Red Continent in the NW (cf. rich Old Red spore assemblages in zoo-geographically peri-Gondwanan Barrandian, Hladil and Bek 1999), (3) limited dispersal of lateritic weathering products around eustatically emerged carbonate plateaux.

This work was supported by the Czech Grant Agency Grant 205/98/0454 and institutional project Z 3-013-912.

References

GALLE A., HLADIL J. and MAY A., 1999. Two new corals from the Koneprusy Limestone (Lower Devonian, Pragian, Barrandian, Czech Republic). *J. Czech Geol. Soc.,* 44: 181-187.

HLADIL J. and BEK J., 1999. Distances between the Early/Middle Devonian Gondwana and Laurussia: Faunal and Spore Dispersals as Compared with Paleomagnetic Data on Paleolatitudes. *Explor. Geophys. Remote Sens. Environ.*, 5: 29-33.

HLADÍKOVÁ J., HLADIL J., KOŠLER J. and JACKOVÁ I., 2000. Evolution of Silurian and Devonian sedimentary environments in the Prague basin: evidence from isotopic compositions of carbon and oxygen and trace element contents in brachiopod shells. W. Oschmann, F.F. Steininger and F.T. Fürsich (Editors), Biomarkers and Stable Isotopes in Palaeontology, Europ. Palaeont. Assoc., Frankfurt a. M., pp. 43-45.

JANOUŠEK V., HLADIL J., FRÝDA J. and SLAVÍK L., 2000. Strontium chemostratigraphy as an indicator of age and duration of reef sedimentation: a case study from Koneprusy Reef of Pragian age (Devonian, Central Bohemia). *J. Conf. Abs.*, 5: 552.

VEIZER J., ALA D., AZMY K., BRUCKSCHEN P., BRUHN F., BUHL D., CARDEN G., DIENER A., EBNETH S., GODDRIS Y., JASPER T., KORTE C., PAWELLEK F., PODLAHA O.G. and STRAUSS H., 1999. $^{87}Sr/^{86}Sr$, $\delta^{13}C$ and $\delta^{18}O$ evolution of Phanerozoic seawater. *Chem. Geol.,* 161: 59-88.

The Pb-Zn Deposits Connected with the Rejuvenation of the Staré Město – Kletno – Marcinków Fault Zone

Mirosław JASTRZĘBSKI

Institute of Geological Sciences, Polish Academy of Sciences, Podwale 75, 50-449 Wrocław, Poland

The Staré Město–Kletno–Marcinków fault zone is a steep, NW-trending polyphase feature which cross-cuts various lithostratigraphic units of the Śnieżnik Metamorphic Complex. The northern part the S–K–M f. z. is about 1,5 km wide and makes the boundary between the Stronie schists and the Śnieżnik orthogneisses. An early ductile deformation gave rise to mylonitisation along this boundary on the fault steeply dipping toward NNE, which developed in a normal regime (Cwojdziński 1983).

The S–K–M f. z. was rejuvenated at brittle conditions in a regime with significant thrust component and some unmetamorphosed conglomerates, considered Late-Devonian – Early-Carboniferous in age, was trapped near Kletno. Among clasts occur pebbles of the surrounding rocks and those of unknown provenence (Kasza 1964). In the vicinity of Marcinków S–K–M fault is located 1 km to the east of the schists-gneisses boundary within quartz-graphite schists (Cwojdziński 1983).

The brittle rejuvenation of the S–K–M fault produced cataclastic rocks. A micro-breccia consists of small fragments of quartz-graphite schists within the very fine-grained matrix, with no concentration of ore minerals in those rocks. The occurrence of mineralization at Marcinków is connected with zone of a cemented tectonic breccia that is associated with the NNW-trending fault running almost parallel to the S–K–M fault and situated several hundred meters to the west of it. The NNW-SSE fault is steeply dipping toward NEE at an angle of 60–80°. Ore minerals: galena, sphalerite, chalcopirite are visible in hand specimen scale. The breccia consists of angular fragments of wall rock (mostly graphite shists), about 1 cm across, which are set in vein material. Components of vein material are mostly quartz, minor calcite and Pb, Zn, Cu, Fe, Sb, As, Ag-sulphides (Wołkowicz 1996).

The younger generation of faults is recognized. Those faults cut perpendicularly older fractures. These are NEE-trending sinistral strike-slip faults. In the vicinity of Kletno, some extension fissures associated with them, were sealed, and quartz-fluorite veins developed (Don 1988).

References

DON J., 1988. Geologia strefy złożowej Kletna – Janowej Góry (Metamorfik Śnieżnika). In: Wybrane zagadnienia geologii i mineralizacji metamorfiku Śnieżnika. Mat. konf. ter. Żelazno, pp. 57-80.

CWOJDZIŃSKI S., 1983. Szczegółowa mapa geologiczna Sudetów 1:25,000, arkusz Stronie Śląskie.

KASZA L., 1964. Budowa geologiczna górnego dorzecza Białej Lądeckiej. *Geol. Sudetica*, 1: 119-161.

WOŁKOWICZ K., 1996. Przejawy mineralizacji w Marcinkowie. *Przegląd Geologiczny*, 4: 386-390.

Numerical Modeling of Magnetic Susceptibility of Rocks Deformed in Transpression Regime

Josef JEŽEK, František HROUDA and Karel SCHULMANN

Faculty of Science, Albertov 6, 128 43 Praha 2, Czech Republic

The model of transpression seems to be one of the most fruitful strain concepts in structural geology and it is broadly used in different geological settings on small or large scale. The aim of a geologist working with the model is to deduce from in situ measurements (collected samples) the possible flow parameters and relate them to macroscopic parameters of transpression which are the initial or final width of the transpression zone, the velocity and the angle of convergence. Answers to these questions are possible due to relatively simple mathematical description of transpression which enables us to compute temporal evolution of strain parameters in transpression zone. Suggested method is of particular significance for magmatic intrusions containing magnetic minerals of known properties. There is a growing number of natural examples of magmatic sills intruding steep transpressional zones where our method can be successfully applied in future (Parry et al. 1997).

Strain parameters can be measured indirectly by means of the AMS method. That is why we describe a procedure of modelling AMS development in transpression. The procedure is based on the relation of the tensor of magnetic susceptibility to the orientation tensor and on theoretic description of magnetic grains behavior in viscous matrix. As Hrouda and Ježek (1999) showed that there are no principal differences between spheroidal and triaxial magnetic particles, we can compute the rotation of magnetic grains using the displacement model developed by Willis (1977). AS follows from the model, the angular velocity of a rigid axial grain rotating in a viscous fluid is equivalent to March (1932) marker rotated at a reduced strain rate. Numerical computation of corresponding finite displacement tensor F can be expressed as

$$\mathbf{F} = \left(\mathbf{I} + \left(q\mathbf{E} + \boldsymbol{\Omega}\right)\Delta t\right)^n$$

where $t = n\Delta t$ is time, E and Ω are symmetric and antisymmetric part of the velocity gradient tensor, and $q = (r^2-1)/(r^2+1)$, where r is grain axial ratio. The cases $q = 1$ and $q = -1$ correspond to Marchian markers – an arbitrarily slender needle and an arbitrarily thin plate, respectively. All other cases can be regarded as rigid particles following Jeffery (1922) equations but they are not necessarily of an ellipsoidal shape. By summation of magnetic susceptibilities of individual grains we compute the bulk magnetic susceptibility corresponding to finite strain accumulated in the transpression zone. On the graphs below we compare finite strain parameters to the corresponding AMS ones. Fig. 1: finite strain intensity $R = X/Y$ (vertical isolines) and Flinn's parameter of strain symmetry K (horizontal isolines). Fig. 2: Jelinek's parameters of AMS, degree of AMS, P (vertical isolines), and shape parameter, T (oblique horizontal isolines). The susceptibility was modeled for a system of prolate uniaxial magnetic grains which were initially oriented uniformly and then reoriented as Marchian needles (passive markers). Both graphs were plotted for different angles of convergence (obliqueness of transpression). The shortening on the horizontal axes of the diagrams expresses the width of the shortened zone in percentage of the initial width.

References

HROUDA F. and JEŽEK J., 1999. Theoretical models for the relationship between magnetic anisotropy and strain: effect of triaxial magnetic grains. *Tectonophysics*, 301: 183-190.

JEFFERY G. B., 1922. The motion of ellipsoidal particles immersed in a viscous fluid. *Proc. Roy. Soc. London*, 102: 161-179.

MARCH A., 1932. Mathematische Theorie der Regelung nach der Korngestalt bei Affiner Deformation. *Z. Kristallogr.*, 81, 285-298.

PARRY M., ŠTÍPSKÁ P., SCHULMANN K., HROUDA F., JEŽEK J. and KRONER A., 1997. Tonalite sill at an oblique plate boundary: NE margin of the Bohemian Massif. *Tectonophysics*, 280: 61-81.

WILLIS D.G., 1977. A kinematic model of preferred orientation. *Bull. Geol. Soc. Am.*, 88: 883-894.