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INTERACTIVE AND 3D MODELING OF PLANAR AND LINEAR STRUCTURES IN THE RELATION TO C-O-H ISOTOPE RATIOS IN THE ŚLĘŻA OPHIOLITE COMPLEX (SW POLAND)

INTRODUCTION

The Ślęża ophiolite is situated in the Fore-Sudetic Block. It belongs, together with the Braszowice, Szklary and Nowa Ruda massifs, to the mafic-ultramafic complexes surrounding the Sowie Mts. gneissic block. Main geological units of the Ślęża ophiolite complex are: 1) metamorphic peridotites (Gogołów-Jordanów serpentinites), 2) ultramafic cumulates (amphibolitized pyroxenites from Tąpadła Pass and Wiry), 3) mafic cumulates (metagabbro of Ślęża Mt.) and sub-volcanic sheeted dykes complex (amphibolites from Wieżyca hill and Kunów).

The scope of this work was to analyse of orientation of planar and linear structures in the Ślęża Ophiolite and their graphical processing with respect to stable isotope results (Mydłowski, Jędrysek 2003 a,b).

MATERIALS AND METHODS

Data. The presented results are based on the measurements of fractures, slickensides and striaes carried out of 64 outcrops in the gabbroic and serpentinized ultrabasic rocks (Jędrysek 1985, Mydlowski 2002). About 6208 measurements of the linear and planar structures have been interpreted. The carbon and oxygen isotope composition of scattered-grain carbonates and hydrogen isotope composition of OH groups in silicates also have been studied (e.g. Jędrysek 1989, 1995, Jędrysek and Sachanbinski 1994, Jędrysek *et al.* 1998).

3D mesostructural analysis and animation. The three-dimensional (3D) animation prepared (Mydłowski, Jędrysek 2003a) has been created using the vector drawing for each outcrop, the standard 1% fixed circle counting procedure and the rose diagrams. It allows drawing the series of surfaces showing the best fitting to the results of equal area projection. These surfaces have been grouped and marked by various colors and textures, in order to improve the quality of the animation. Additionally, the „bird's of eye view" has been applied. The entire composition has been rendered.

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Interactive geochemical and mesostructural cross-section analysis and presentation. The goal of the interactive presentation (Mydłowski, Jędrysek 2003b) was to visualize the results of statistical analysis and the relation between two cross-sections cutting the ophiolite massif. This presentation shows relationships between deformation structures and stable isotope ratios in the Ślęża ophiolite rocks. The structural analyses have been carried out using the eigenvectors, which consist of three main vectors of data from measurements. These eigenvectors are crossing with each other at the angle of 90°. Although the mutual orientation of eigenvectors is constant, they may rotate relative to the center of the projection sphere. In our modeling the eigenvectors arrangement is rotated in order to adjust the E_3 eigenvector fitting to the greatest cluster of the data distribution. The E_1 eigenvector represents the maximum dispersion of the data distribution (Table 1) and shows the best fitting relative to the normal to the plane, which, in turn, contains the measured linear structures (or normal to the planar structures). Besides, the E_1 value consists the sum of squared angular deviations of these data from the plane (Vollmer 1990). On the other hand, the remaining eigenvectors E_2, E_3 belongs to this plane. In this case the sum of their values is equal to the number of measured data minus E_1 value.

characteristic of the data distribution	eigenvalues		
	E_1	E_2	E_3
cluster data distribution:	[0	0	N]
girdle data distribution:	[0	N/2	N/2]
uniform data distribution:	[N/3	N/3	N/3]

Table 1: Three extreme cases of the data distribution around the eigenvectors. Symbols E_1, E_2 i E_3 indicate the values of minimum, median and maximum of the respective eigenvector. N indicates number of measurements.

The samples isotopically analysed do not always reflect the same location as the points of the tectonic measurements. For that reason the $\delta^{13}C$, $\delta^{18}O$ and δD values have been calculated according to kriging method, hence presented on the respective cross sections as interpolated values. Besides, special pointer has been created to enable to find the distance to the nearest sampling point.

RESULTS AND DISCUSSION

3D mesostructural analysis and animation. In the western part of Gogołów-Jordanów serpentinite massif a distinct order in orientation of the slickensides is observed, due to high value of the cylindricity, ranging from 0.6 to 0.8 (Fig. 1).

The negatively correlated increase and decrease of the cluster (from 0.25 to 0.55) and the girdle parameters (from 0.25 to 0.45) indicate the presence of a dominant slickenside set, and other more complementary slickenside set. The supplementary slickensides are more detectable in these areas where the girdle increases. In the eastern part of Gogołów-Jordanów serpentinite massif, the high dispersion in the slickenside system is noticeable. It is evidenced from increasing uniformity value from 0.5 to 0.6 (Mydłowski, Jędrysek 2003b). Despite extensive variation in the character of deformation the apparent symmetry of the western and eastern parts of serpentinite massif can be observed on 3D animated presentation (Fig. 1, Mydłowski, Jędrysek 2003a).

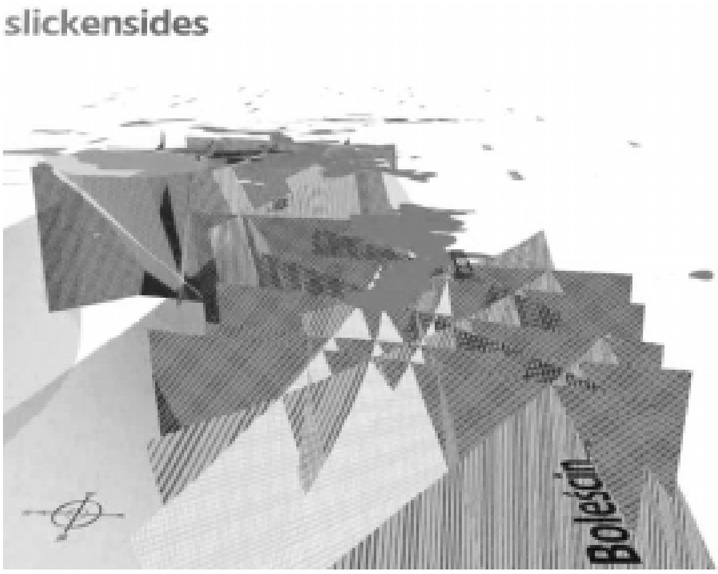

Fig. 1: An example 3D presentation. The orientation of the slickensides in the western part of Gogołów – Jordanów serpentinite massif

Interactive geochemical and mesostructural cross-section analysis and presentation. The relative orientation of the fissures is presented as the cylindricity, which depends on the cluster parameter calculated due to the model (Fig. 2, Mydłowski, Jędrysek 2003b). At each outcrop at least one dominant fracture system can be observed in the visual model constructed (*e.g.* outcrops 8, 9, 15, 16, 17, 19). In the outcrops 9, 15, 17 (from Kiełczyn through Książnica to Gogołów) the eigenvector E_3 changes orientation from 340/7 through 21/16 to 67/22. In contrast to the regional-scale variation, no outcrop-scale variation has been observed. From the model it can be concluded that one dominating concentric fracture system outward from the center of the Gogołów-Jordanów massif has been formed. It consists of several fan-shaped systems.

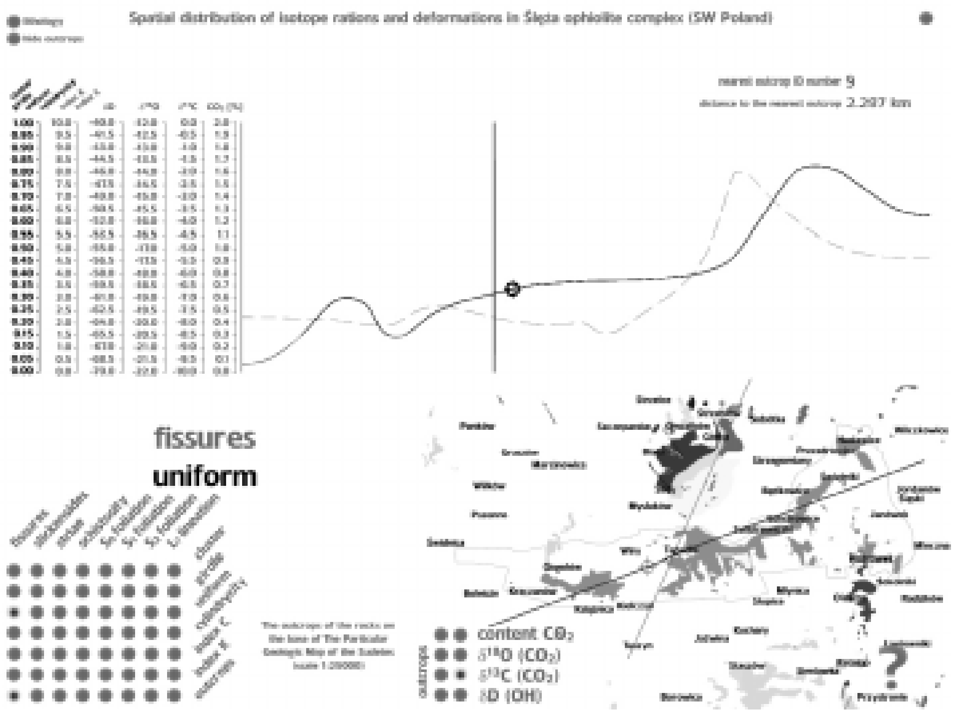

Fig. 2: Variations in the uniformity of fissures orientation (solid line curve) compared to $\delta^{13}C$ value in scattered-grain ophicarbonates (dashed line curve). Variations in these parameters are show along the SWW-NEE cross-section in Gogołów – Jordanów massif (see Mydłowski, Jędrysek 2003b).

CONCLUSIONS

The plunges of the most planar and linear structures presented aremainly near about 60°. The variation in the orientation of the ductile deformations seems to be narrower, than in the brittle one. Distinct geometric relation between fractures and slickensides suggests their common origin. The orientation of the fractures and slickensides shows the fan-shaped symmetry oriented toward the central part of the Ślęża ophiolite complex. Concentric orientation is probably resulted from increasing volume of peridotites due to serpentinization or/and folding the entire ophiolite. Clear correlation between $\delta^{13}C$ values and the orientation of the fractures and slickensides has been observed. The tectonic structure of the Eastern part of the Gogołów-Jordanów appears to be much more diverse than the Western one.

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