coherent and platform-independent system for interpretation of whole-rock geochemical data that would have high-level plotting capabilities. It should be straightforward to use by ordinary geochemists but, at the same time, easily expandable by the more demanding ones.

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Evolution of Ślęża and Nowa Ruda Ophiolites: Oceanic and Continental Stages Recorded in Stable Isotope Composition of Silicate Minerals

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Hydrogen and oxygen isotope ratios in mafic and ultramafic rocks of Ślęża (Sl) and Nowa Ruda (NR) ophiolite complexes (N margin of Bohemian Massif, Sudetes Mts., SW Poland) were analysed. This was done to assess the role of ocean-floor metamorphism and continental processes in the evolution of these two ophiolites.

Geological position of the NR and Sl has been briefly described in another abstract by the same authors (this volume). Structural evolution of rocks is not necessarily accompanied by formation of new minerals; however, it may apparently result in the redistribution of isotope ratios in the deformed primary minerals. Thus, isotope analyses may be a good tool to reconstruct geological conditions of structural evolution of rocks. Mesostructural observations in Sl revealed the presence of primary magmatic lamination S_0 and metamorphic and/or tectonic foliations S_1, S_2, S_3 and S_4. Moreover, 6 systems of slickensides were observed. In the case of the sheeted dykes member (amphibolites), the S_0 may be considered as a sequence of rhythmic variations of the structure, parallel to the margins of the dykes. In lower members of the ophiolite complex, the S_0 is dark and light lamination. In the metagabbro, the leucocratic laminae are composed predominantly of feldspars and products of their hydrothermal decomposition. The melanocratic laminae are composed mostly of diallage and uralitic hornblende. In the ultramafic cumulates the light laminae consist mostly of chlorites, tremolite and primary calcite, and the dark ones are relics of pyroxenes and amphiboles. In the tectonites (serpentinites), the S_0 exists in the presence of flat sectors composed predominantly of pyroxene relics, and the overlying, spaces are filled mostly with olivine and products of its decomposition.

The S_1, in general, is parallel to S_0, but sometimes one can observe centimetre-scale intrafoliation folds F_1 formed during the D_1 deformation. Despite that in the outcrop scale, no F_2 folds were registered, the S_2 foliation is very clear, especially in ultramafic rocks. It is developed as typical schistosity possibly formed during deformation D_2. Generally, the S_2 is perpendicular to S_0 and S_1. The D_3 deformation of S_2 yielded meter-scale open folds F_3. The S_3 surfaces are not penetrative and occur only in ultramafic rocks as the axial cleavage in F_3 folds. The F_4 folds were registered in schistose serpentinites and amphibolites as small knick folds with cataclasis developed along axial planes (S_4). The S_4 surfaces in ultramafic cumulates occur only in a few zone of cataclasis.

In non-mineralised (ore minerals are accessory or not observed) rocks, the $d^{18}O$ whole-rock (wr) value varies from 3.97 ‰ (Słupiec tectonised gabbro) to 8.35 ‰ (G-J serpentinites). These values are typical for ophiolitic sequences. It has been suggested earlier that ocean water was an important factor controlling hydrogen isotope ratios in chlorite from rodingites in GJ and sulphur isotope ratios from amphibolites in SM. Therefore, it can be expected that advances in ocean-floor metamorphism (higher w/r ratio and lower temperature) would leave hydrogen and oxygen isotope offprint in whole rocks, too. Therefore, vertical profiles in Sl ($\delta^{18}O$) and NR (δD and $\delta^{18}O$) ophiolites were constructed, and isotope values versus the distance from petrologic Moho were plotted (Figs 1-3). In general, overall vertical distributions of δD and $\delta^{18}O$ values do not show a regular pattern. Nonetheless, the upper horizons of gabbro (dominantly fine-grained) close to the contact with subvolcanic rocks (amphibolites), show clear upward decrease in δD value in NR (Fig. 1), increase in $\delta^{18}O$ value in NR (Fig. 2) and decrease in $\delta^{18}O$ value in Sl (Fig. 3).

Temperature and mineralogical composition are the dominant factors governing D and O isotope fractionation in the water–rock system. Metagabbro is composed of minerals showing slightly negative O and D fractionation factors in mineral-water system, and the α factor decreases with temperature decrease. However, amphibolites show significant contents of albite, quartz, carbonates and zeolites which, in turn, show strongly positive O isotope fractionation in the mineral-water system. It is, therefore, expected that an increase in sea-water alteration during potential ocean-floor metamorphism in temperatures between 100 to 500 °C, and decrease in temperature of this alteration, should result in a decrease in $\delta^{18}O$ in metagabbro, and higher $\delta^{18}O$ values in the amphibolites. This is the case in the SI $\delta^{18}O$ profile (Fig. 3) but not that in the NR profile (Fig. 2). This suggests that the SI ophiolite rocks were strongly altered due to ocean-floor metamorphism, but the NR rocks much less, or oceanic traces were overprinted by later continental processes. The NR δD profile supports this hypothesis, as the D/H ratios in the NR are very low and the NR δD value decreases upward suggesting a decrease in temperature of the rock alterations and increasing role of meteoric origin fluids. Likewise, $\delta^{18}O$ and δD values and profiles in GJ serpentinites do not show any relation to oceanic alteration (Fig. 3 and 4) or potential influence of S-S granite (Fig. 1, pp. 38). Therefore, we suggest that the S_1 formed in the oceanic stage of the evolution of these ophiolites.

δD values show gradual increase and $\delta^{18}O$ values show gradual decrease, from margin into the centre of the GJ serpentinite body. This suggests that during serpentinization(s), w/r ratio was (were) much higher in the marginal parts than in the centre of the serpentinite body. This suggestion may be supported by D/H isotope analysis of the whole rocks and carbon and oxygen isotope analyses of scattered ophimagnesites (see another abstract by the same authors in this volume). On the other hand, tectonic deformations in GJ, which are considered a result of D_2, are extensive and seem more "plastic" in the marginal parts of the serpentinite body. We suggest that this is possibly caused by the gradient of water flow penetrating the massif during deformations and the main antigoritic serpentinization. Low hydrogen and oxygen isotope ratios evidence significant influence of fluids of meteoric origin during serpentinization and formation of the S_2.

It is expected that hydrothermal alteration due to S-S intrusion should result in significant variations in isotope ratios, especially in δD in the western part of the GJ. However, this is not a very clear pattern (Fig. 1, pp. 38). Thus, apparently, the S-S intrusion can be related to D_3 deformation, however, likewise the potential D_4 deformation, no clear isotope evidence was found in the scale of the massif. Nonetheless, earlier isotope studies evidence that vein chrisotile from the S-S contact zone was formed due to the granite intrusion, and lizardite was formed at surficial temperatures under isotope equilibrium with water of meteoric origin.

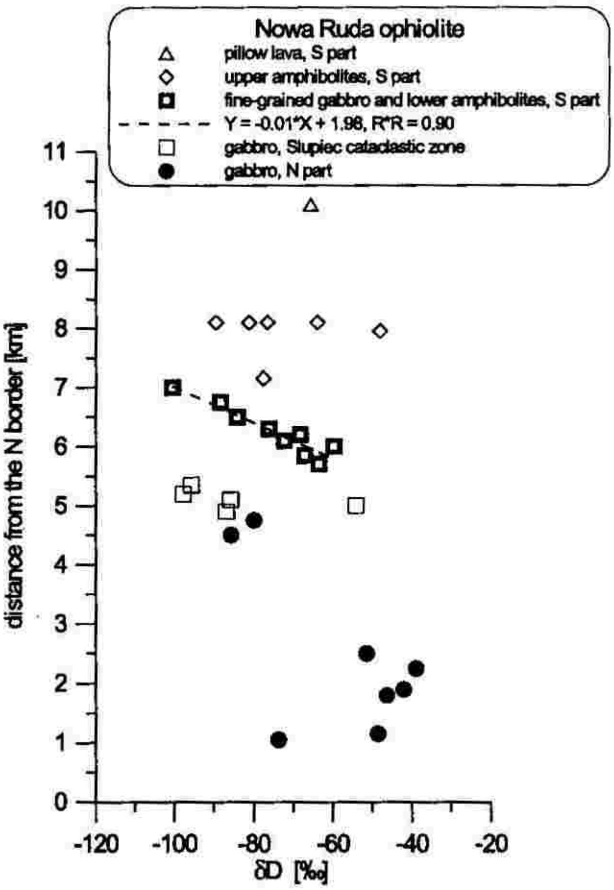

Fig. 1. δD versus distance to the N border (the potential Moho) of the Nowa Ruda massif.

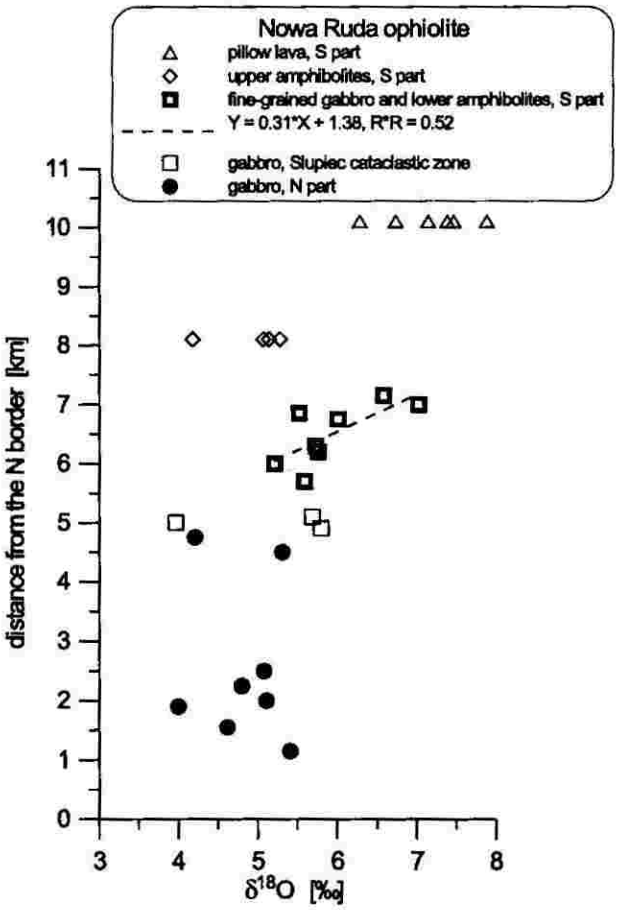

Fig. 2. $\delta^{18}O$ versus distance to the N border (the potential Moho) of the Nowa Ruda massif.

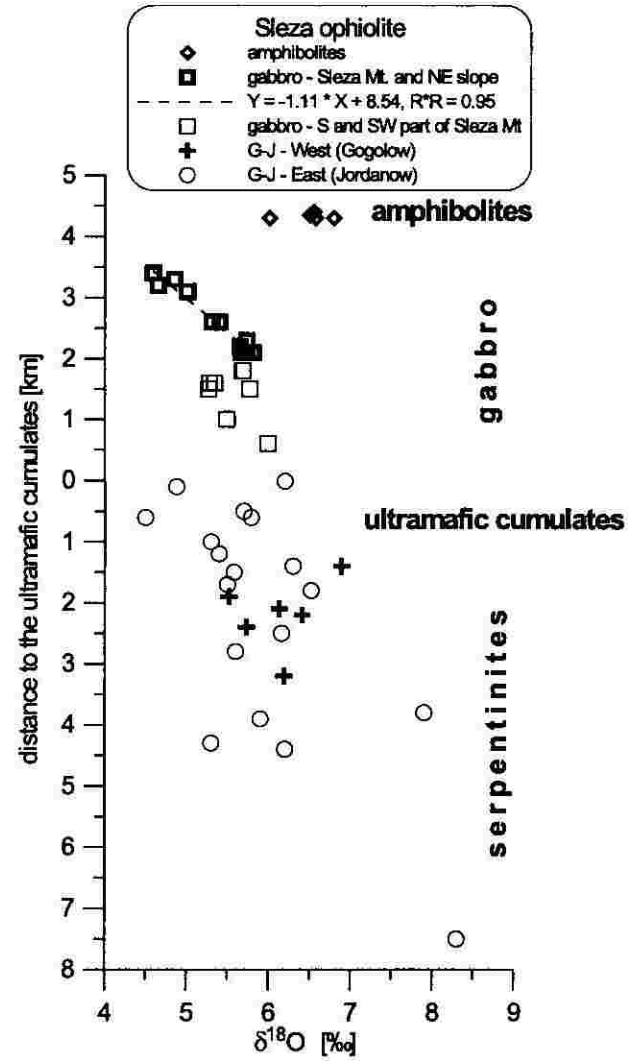

Fig. 3. $\delta^{18}O$ versus distance to the ultramafic cumulates (the potential Moho zone) of the Ślęża massif.

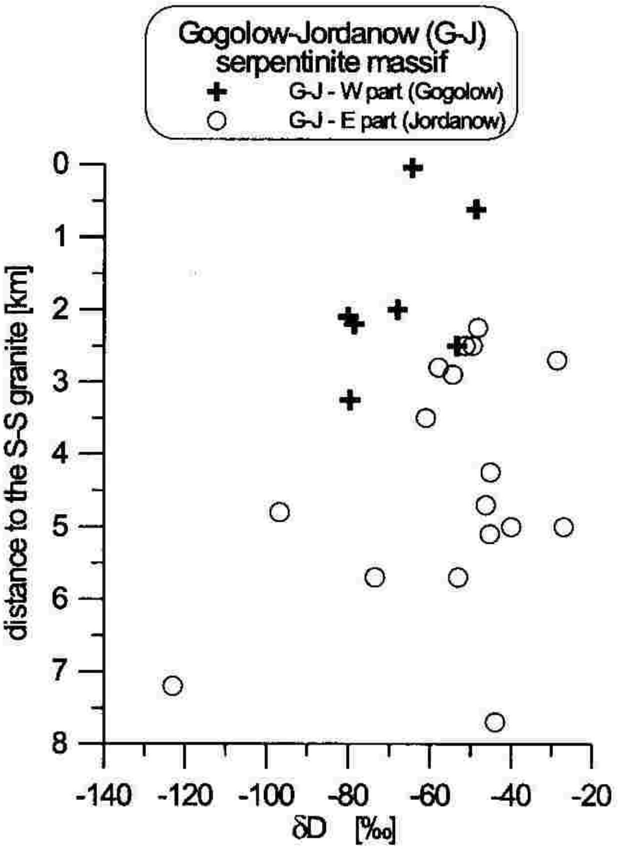

Fig. 4. δD versus distance to the contact with S-S granite massif.

Evolution of Ślęża and Nowa Ruda Ophiolites: Oceanic and Continental Stages Recorded in Stable Isotope Composition of Oxides, Carbonates and Sulphides

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Carbon, oxygen and sulphur isotope ratios in oxides, carbonates and sulphides from mafic and ultramafic rocks of Ślęża (Sl) and Nowa Ruda (NR) ophiolite complexes were analysed. This was done to assess the role of ocean-floor and continental processes in ore deposit formations in these two ophiolites.

These ophiolites belong to the mafic-ultramafic massifs surrounding the significantly older Precambrian Sowie Mts. gneiss block (SM). The NR ophiolite is situated at the SW margin of the SM. Its northern part is composed of variable petrological types of altered gabbro (metagabbro) and the southern, subvolcanic part, consist of metadiabases and altered pillow lavas. The northern and southern parts are divided by the Słupiec cataclastic zone. The Ślęża ophiolite represents an almost complete ophiolite sequence comprising: Gogołów–Jordanów (G-J) serpentinite massif (ultramafic member), Ślęża Mt. gabbro (mafic, plutonic member) and Wieżyca Hill (WH) metadiabases and amphibolites (volcanic member). The ophiolite is in overturned position and the pillow lava and sedimentary members were