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Origin of silicate minerals in Triassic carbonate rocks from the Krížna Unit in the Tatra Mts..

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Abstract. Carbonate rocks (57 samples) from the profile of Triassic of the Krížna unit in the Tatra Mts. as well as their separated non-carbonate components were analysed.
The content of silicates and chlorite and chlorite/smectite minerals is higher in the rocks described, as they were formed in more marginal parts of Krížna basin. This indicates that the content (and composition) of silicates in the Triassic carbonate rocks of the Krížna unit was controlled by paleogeography. Most of the silicate minerals (clay minerals, quartz, feldspars) from the examined rocks seem to be of detrital origin. The composition of clay mineral assemblages from limestones and dolomites is similar. This implies that the influence of diagenetic dolomitization on clay minerals was negligible. No diversity was found in the mineralogical composition of silicate assemblages within carbonate-marl alternations. Marls seem to be more micas and feldspars rich in proportion to quartz. The differences in clay mineral content and clays/quartz ratio in carbonate-marl alternations are probably connected with changes in the rate of supply of detrital material from source areas. Detrital clay minerals identified in the examined rocks could be eroded from a crust of chemical weathering or from bed-rocks. Absence of kaolinite and presence of chlorite and/or chlorite/smectite minerals could indicate the low intensity of chemical weathering in the source area.
Some quartz and feldspars, as well as small amount of fibrous illite, appear to be authigenic. Euhedral or subhedral quartz crystals found in pseudomorphs after evaporitic minerals (gypsum?) are evidently of authigenic (diagenetic) origin. The common presence of quartz crystals and aggregates with numerous voids after dissolved carbonate minerals indicates wide-spread quartz crystallization during diagenesis. Euhedral morphology and high purity of chemical composition of K-feldspars strongly suggest their authigenic origin. A relatively late diagenetic growth of K-feldspars is probable (without contact with Na rich brines of marine origin).

Key words: Triassic carbonate rocks, Tatra Mts., detrital silicate minerals, diagenetic silicate minerals

Introduction

The purpose of this study is to determine the distribution of silicate minerals in the profile of Triassic carbonate rocks of the Krížna unit and to present an interpretation of their origin in terms of Triassic source areas distribution, sedimentation and diagenesis). Results of preliminary studies of non-carbonate minerals from the Krížna unit carbonate rocks were published by Skiba and Michalik (1999).

Krumm (1969) presented the distribution of clay minerals in the Triassic basin in Europe. In his interpretation the distribution is governed by the distance from continental source areas and by transformation and neomorphism in the sedimentary environment. This interpretation is supported by another author (e.g Baud, 1987), but also the diagenetic overprint is suggested (Baud, 1987). Clay minerals in the Triassic carbonate rocks from the Upper Silesia (Poland) are mainly of detrital origin (Łatkiewicz et al., 1995). Some non-carbonate minerals from Triassic carbonate rocks may have originated from diagenetic alterations of pyroclastic material (e.g. Masaryk et al., 1995, Koszowska et al., 1998, Viczián et al., 1998). Diagenetic growth of authigenic quartz and feldspars was described in Triassic carbonate rocks from different localities (Füchtbauer 1950, Baud, 1987, Michalik, 1991, Viczián, 1992, Mišík, 1994, 1995).

Material and analytical methods

Samples were collected from the profile of the Krížna unit in the Jaworzynka Valley and on the SE slopes of the Skupniów Upłaz in the Tatra Mts. Studied rocks represent the most complete profile of Krížna unit outcropped in the Tatra Mts.

Carbonate rocks (57 samples) as well as their separated non-carbonate components were analysed. Non-carbonate components of limestones, marls and dolomites were separated by dissolution of calcite and dolomite in acetic buffer. Organic matter was oxidised using hydrogen peroxide. Iron oxides removal was performed according to the Mehra & Jackson (1963) method. Pelitic fractions (<2mm) from selected samples were separated by centrifugation. XRD, IR, optical microscopy, and SEM-EDS methods were used to determine mineral composition, morphology and chemistry of carbonates and non-carbonate components.

Results

In the Ladinian section of the studied profile, dolomites and dolomitic marls are present whereas in the Lower Triassic section (seis, kampil) dolomites, limestones, marls, and siliciclastics occur. Mica, quartz, and feldspars (mainly K-feldspars) are the main silicate minerals in the examined rocks (present in most of samples). Sporadically, chlorite (in residue from four samples) and chlorite/smectite regular mixed layer minerals (in one sample) were found. Analysis of X-ray diffraction patterns and Ir values suggest that illitic material is dominated by illite/smectite mixed layer minerals with a high illite content (ISII) or a mixture of illite and I/S minerals (e.g.: I + ISII) (Środoń & Eberl, 1984). Intensities of basal chlorite reflections implies the presence of Fe-chlorites rather than Mg-ones. The chlorite/smectite mineral seems to be similar to the mineral described by Morrison and Parry (1986) from the Permian red beds deposits. The shape of clay mineral flakes is usually irregular. Small amounts of authigenic fibrous illite overgrowing on detrital micas can be noticed in some samples.

SEM observations of residues separated from samples rich in K-feldspars (determined by XRD) suggest that part of K-feldspars is present in the form of small (<5mm) rhombohedral crystals of pure chemical composition. Euhedral or subhedral quartz crystals (from microns to a few millimetres in size), both in clusters and dispersed, were noted during the examination of thin sections. Highly porous euhedral, subhedral, and concretional forms of quartz can be seen in SEM. In one sample, apatite concretions of a few millimetres were found.

In Lower Triassic (seis, kampil) and Upper Ladinian carbonate rocks, insoluble residue constitute from 10 to 90 wt. %. In Anisian and Lower Ladinian rocks, content of residue is lower (usually below 10 wt. %).

Discussion of results

The content of silicates and chlorite and chlorite/smectite minerals is higher in the rocks described, as they were formed in more marginal parts of Krížna basin (Kotański 1965, Iwanow 1965, Lang 1997). This indicates that the content (and composition) of silicates in the Triassic carbonate rocks of the Krížna unit was controlled by paleogeography.

Irregular shape and tattered edges of clay minerals flakes and other silicates grains suggest that most of the silicate minerals (clay minerals, quartz, feldspars) from the examined rocks seem to be of detrital origin.

The composition of clay mineral assemblages from limestones and dolomites is similar. This implies that the influence of diagenetic dolomitization on clay minerals was negligible. This conclusion is not in agreement with those presented by other authors (e.g. Krumm 1969, Baud 1987), who suggest the important role of Mg-rich solutions in the formation of corrensite and/or chlorite.

No diversity was found in the mineralogical composition of silicate assemblages within carbonate-marl alternations. Marls seem to be more micas and feldspars rich in proportion to quartz. The differences in clay mineral content and clays/quartz ratio in carbonate-marl alternations are probably connected with changes in the rate of supply of detrital material from source areas (and possibly in changes of intensity of erosion). Similar diversity was observed in Muschelkalk from Upper Silesia (Łatkiewicz et al., 1995).

Detrital clay minerals identified in the examined rocks could be eroded from a crust of chemical weathering or from bed-rocks. Absence of kaolinite and presence of chlorite and/or chlorite/smectite minerals could be explained by the low intensity of chemical weathering in the source area and/or by longer distance from the source area (*cf.* Krumm (1969). Sedimentological studies of Triassic profile of the Krížna unit (Kotański 1963, Iwanow 1965, Lang 1997) exclude the second hypothesis. Chlorite and chlorite/smectite originated rather from erosion of source area rocks (slightly weathered) rich in these minerals.

Some quartz and feldspars appear to be authigenic. Euhedral or subhedral quartz crystals found in structures described by Lang (1997) as pseudomorphs after evaporitic minerals (gypsum?) are evidently of authigenic (diagenetic) origin. In Mišík's (1995a) opinion, similar megaquartz can precipitate from highly diluted solutions during late diagenesis. Substrates could be delivered from partly dissolved detrital silicates in the surrounding sediment. Transport of silica solutions was controlled by the permeability of the rock (*cf.* Mišík 1995b). In the studied rocks, porosity connected with dissolution of evaporitic minerals silica solutions could facilitate silica migration. The common presence of quartz crystals and aggregates with numerous voids after dissolved carbonate minerals (during laboratory treatment) indicates wide-spread quartz crystallization during diagenesis. Basing on Chafetz and Zhang (1998) conclusions related to early diagenetic growth of quartz in sebkha environment it is possible to accept also early diagenetic growth of quartz in studied Triassic rocks.

Euhedral morphology and high purity of chemical composition of K-feldspars strongly suggest their authigenic origin (*cf.* Kastner & Siever, 1979). Presence of authigenic feldspars (mostly K-feldspars but also albite) is common in Triassic carbonate rocks (e.g. Baud 1987, Michalik 1991, Mišík 1994). A relatively late diagenetic growth of K-feldspars is probable (without contact with Na rich brines of marine origin).

Authigenic chlorite/smectite mineral was not found, but its presence cannot be excluded. According to the stability diagram presented by Morrison and Parry (1986) the field of stability of K-feldspars is adjacent to the field of stability of chlorite/smectite minerals. Presence of small amounts of authigenic illite indicates low activity of Mg ion.

Conclusion

1. Content of silicates and partly their composition is controlled by paleogeography.

2. Most of non-carbonate minerals are of detrital origin and were transported from source areas characterised by the low degree of chemical weathering.

3. Diagenetic quartz is relatively common.

4. Authigenic K-feldspar, illite, and probably chlorite/

5. smectite are related to late diagenesis

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