THE BRAIDED STREAM DEPOSITIONAL SYSTEM IN LOWER TRIASSIC OF THE NORTHERN VEPORICUM (Western Carpathians, Slovakia)

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Abstract: Lower Triassic sediments of the Northern Veporicum are characterized by lithological features indicating the sedimentary model of braided alluvium. Among sedimentary lithofacies channel facies prevail that alternate in short cycles with fining-upward pattern. River bed facies and river accumulations and downsand facies dominate, typicallly of tabular bodies with planar current bedding and scour (channel) current bedding, associated with the origin of three-dimensional dunes and bars in river beds. Flood facies, represented by river flat sediments or eventually by cloudburst sediments, are evolved just locally. Major part of fine-grained sediments in sections is genetically related to abandoned parts of riverbeds, from which local shallow basins could have evolved. Markedly unimodal system of transport is documented by the orientation of current beddings, where directions from NW-SW and NW-SE prevail.

Key words: braided alluvial depositional system, Lower Triassic, Northern Veporicum, Western Carpathians

INTRODUCTION

In Northern Veporicum tectonic unit Lower Triassic sequences are predominantly composed of clastic sediments of sandy and fine-gravel granularity. They form a part of a lithostratigraphic unit called the Lúžňa Formation, originally defined by Fejdiová (1980) in Tatricum and later re-defined by Vozárová and Fejdiová (1996) also in Northern and Southern Veporicum and Zemplinicum.

Common features of all occurences of Lower Triassic sediments in the Northern Veporicum unit consist of: 1. high structural and mineralogical maturity compared to footwall Permian sediments; 2. break of deposition and hidden discordance in relation to its proximate footwall, Permian sediments. It is necessary to stress that Lower Triassic sediments were deposited directly on Permian sequences in this unit. This implies that transpressional/transtensional structures, that enabled the origin of continental Permian sedimentary basins, continued in the Lower Triassic sedimentary space and they were a basis for the origin of a large-scale Mesozoic marine sedimentary space. The structural plan of the postcollisional stage of the Hercynian orogeny directly influenced the evolution of sedimentary basins in the Alpinian stage of orogeny.

LITHOLOGY

Coarse-grained siliciclastic sandstones are prevailing sediments, associated with fine-grained and sandy conglomerates on one side and with medium- to corse-grained sandstones on the other side. Fine-grained sediments, such as siltstones and claystones are preserved just locally. The geometry of sedimentary bodies changes regionally and indicates the presence of laterally extensive drainage areas. Bedding bodies are tabular, eventually lens- or wedge-shaped. Petrographically, these sediments have high structural and mineralogical maturity, low concentration of clay matrix, moderate to good structural grading. Conglomerates belong to oligomict types with absolute prevalence of quartz chips and with a grain-supported structure. Sandstones belong to the group of quartz arenites with the affinity to the group of sublitarenites. Just the base of the sequence is an exception, where predominantly sublitic arenites occur, but also with a high (85 – 90%) content of quartz grains. Varietes of sandstones with relatively higher content of matrix (about 10-15%) are very rare.

In the profiles studied, repeated channel complexes (Fig.1) form the vertical sequence of facies. The complexes are represented predominantly by channel bars, consisting at their basis mostly of massive or horizontally bedded fine-grained conglomerates that are vertically replaced by coarse-grained sandy sediments with planar or channel, large-scale cross-bedding. In exposures sets of current bedding have apparent unimodal orientations. Flow, planparallel horizontal lamination is common in both types of these sediments. Upper parts of channel bars are represented by medium- to fine-grained sandstones with ripple bedding. Contacts between individual bodies of channel bars are often erosive, lined with intraclasts of siltstones and claystones. The thickness of individual channel sets is small, mostly not exceeding 2 – 2.5 m. Appart from these sediments, representing deposits of migrating channel bars in a river bed (this means longitudinal and transversal bars), relicts of channel fillings were identified. The filling of these channels consists of massive or horizontally bedded fine-grained conglomerates with a structure supported by rounded pebbles. Most probably in the original system they represented secondary channels that in a braided stream eroded previously formed channel bars.

Based on the lithofacies features above presented it is possible that in the Northern Veporicum Lower Triassic coarse-grained siliciclastic sediments have been deposited in rivers of braided stream type, with low grade of sinusoity and relatively high gradient, in streams reaching a relatively high speed.

Fine-grained sandstones with horizontal-or ripple lamination, interupted by solitary, graided beds of sandstones or scattered riverbeds with erosion basis, filled by coarse-grained sandstones, are interpreted as flood sediments of river flat or as cloudburst sediments. Such sediments are possible to expect during sudden lowering of the gradient in a system of braided streams and consequently lowering of the transport rate, that finally resulted in local increase in sinusoity of riverbeds and thereby in the evolution of meanders and flood bursts. Rarelly, sediments of shallow abandoned basins, represented by shales, siltstones, locally with carbonate pedogeneous horizons, remained preserved.

PETROLOGY

Conglomerates

Quartz is a dominant component among clasts: milky and pink quartz varieties along with dark-pink, grey to black. In basal parts of the Lúžna Formation fragments of rhyolite-dacite volcanics occur, rarely fragment of microgranite with typical granophyric texture was found. Black fragments of turmaline-bearing rocks belong to resistent clasts. They are composed of fine-grained aggregate of turmaline and quartz. All presented types of rocks are common components of in Permian conglomerates (the Predajná Formation) in proximate footwall of Lower Triassic sequence. They are derived from metamorphic complexes of the Northern Veporicum crystalline basement as well as from the lowermost Permian sequences.

Generally, conglomerates of the Lúžna Formation are mineralogically very mature sediments. They belong to the group of oligomict conglomerates. Quartz forms more than 90% of clasts, even in basal parts, while its concentration increases in vertical direction and reaches more than 95% or up to 100% of all clasts. A substantial part of rounded pebbles of quartz is well shaped, suggesting not only long transport but also mainly cyclic redeposition. However, entirelly angular clasts of quartz occur too.

Angular grains of pale-grey and beige K-feldspars represent a special detritic component in conglomerates. They occur rarely just in basal layers of the sequence.

Intraclasts of violet, beige-red, as well green shales form also a part of the detritus, indicating processes of syndepositional erosion.

Sandstones

Most sandstones belong to the group of quartz arenites, eventually their mineral composition gradually reaches to the group of sublitharenites, less often to subarcoses. Significant part of sandstones is typical by a subsidiary structure of grains, just with a low content of matrix (prevailingly up to 10%). An effect of pressure-induced dissolution occurs on the contacts of grains. Only a part of the sandstones belongs to the group of quartz wackes (with more than 15% of matrix). Generally, sandstones that belong to the group of arenites are moderatelly to well, rarely very well structurally sorted with coeficient of sorting usually varying in the range from 0.35 to 0.50ϕ.

Quartz is a dominant mineral component in sandstones of the Lúžna Formation. Nearly all genetic types of quartz have been identified, coarse-grained polycrystalline, fine-grained polycrystalline with oriented fabric, pressure-deformed cataclastic, monocrystalline as well as volcanogenic quartz. The surface of quartz grains is very often well to fully shaped. Relicts of their surface are traceable thanks to the fine coating by Fe-oxides on their surface. Occasionally, inclusions of muscovite, rarely rutile and zircon were detected in quartz grains. Volcanogenic quartz contains preserved rests of original volcanic glas inside magmatic corrosive bays.

Just a small part of detritus is formed by less stable components – fragments of rhyolite-dacites and their pyroclastics and feldspars. Generally, fragments of volcanics prevail over feldspars. It is possible to conclude that in both minor components especially their relatively more stable varieties are present. Therefore, felsitic varieties are dominant among fragments of rhyolite-dacites, while microcline and ortoclase are dominant among feldspars. Especially in basal layers of the Lúžna Formation structurally variable range of fragments of volcanics occurs, i.e. again microcrystalline, spherolitic varieties, pyroclastics with indications of ignimbritic structure. In direction to superincumbent beds and in medium- to fine- grained sandstones varieties with blastofelsitic structure prevail. Alkaline feldspars are usually not secondary altered. They occur just seldom (1-3%). Rarely (1-2 grains in a whole section) plagioclases were detected, especially in basal parts of the Lúžna Formation. Seldom fragments of clastic micas, muscovite and rare heavily secondary-altered biotite have been found in sandstones. Heavy mineral assemblage responds to high grade of mineral maturity of sandstones. It is represented predominantly by the assemblage zircon-turmaline-rutile.

Quartz cement is typical for sandstones of the Lúžna Formation. It occurs in the forms of regenerative or syntaxial cement while the remaining parts of the quartz cement is formed by microcrystalline aggregate. The original shape of grains is possible to recognize just in a case, when the surface of a grain was covered by fine coating composed of iron oxides or by fine sheet of illite. Initially, clayey rim around quartz grains originated most probably in the initial beginning of the early stage of diagenesis and it is older than the quartz cement that fills pores between grains. Similarly, seldomly preserved carbonate cement, that fills pores or their parts only in the form of fine-grained aggregates or rhombohedrons, is older than quartz cement. Carbonate cement usually does not filll all pores in the structure of sandstones and it is combined with the quartz cement replacing it in the process of diagenetic alteration.

CONCLUSION

In sediments of lower part of the Lúžna Formation, several lithofacies indicating river deposits with low grade of sinusoity were identified, in literature generally reported as braided streams. This sedimentary model is formed by rivers with steep slope and relatively high speed of stream flow, that within the riverbed are split up into a network of shallow and broad channels, mutually divided by sandy or conglomerate accumulations and big floor dunes. This interpretation is supported by the following facts:

1. All basic lithofacies form areally large sedimentary bodies, that discordantly cover the footwall and fill undulations of the initial relief.

2. Coarse-clastic sediments generally prevail, represented by fine-grained conglomerates and very coarse-, coarse- and medium-grained sandstones. Fine-grained sediments (fine-grained sandstones, siltstones and shales) are preserved only sporadically.

3. Among sedimentary lithofacies channel facies prevail that alternate in short cycles with a fining-upward pattern. River bed facies and river accumulations and downsand facies dominate, typicallly of tabular bodies with planar current bedding and scour (channel) current bedding, associated with the origin of three-dimensional dunes and bars in river beds. Flood facies, represented by river flat sediments or eventually by cloudburst sediments, are evolved just locally. Major part of fine-grained sediments in sections is genetically related to abandoned parts of riverbeds, from which local shallow basins could have evolved. Markedly unimodal system of transport is documented by the orientation of current beddings, where directions from NW-SW and NW-SE prevail.

4. Cyclic sedimentation occurs within short cycles but also within cycles of medium size, in both cases with apparent tendency of lowering of grain size in direction to upper parts.

5. Sediments of the Lúžna Formation are prevailingly structurally low- to well-graided and mineralogically mature. They document processes of chemical weathering and short tectonic stability in the period before the origin of Lower Triassic sedimentary space.

6. Variation of warm, relatively humid and semiarid/arid climatic conditions is indicated by the prevalence of quartz cement and mineral maturity of sediments and on the other hand by relicts or ferric as well as clayey cements around clastic grains. Also the local occurence of sandstones with fully shaped quartz grains and with high level of grading could indicate the redeposition of eolian sediments, associated with river flat during dry periods. Dry and warm climatic conditions are suggested by carbonate pedogeneous horisons, occuring in deposits of abandoned channel fillings.

7. Vertical profile of the Lúžna Formation documents gradual transition from the aluvial regime, with rivers with low sinusoity, directly towards shallow and broad litoral zone, with laterally evolved beach sediments as well as littoral sabkhas, passing into an open shelf. Vertical transition between continental and littoral/shallow-marine sedimentation was rapid.

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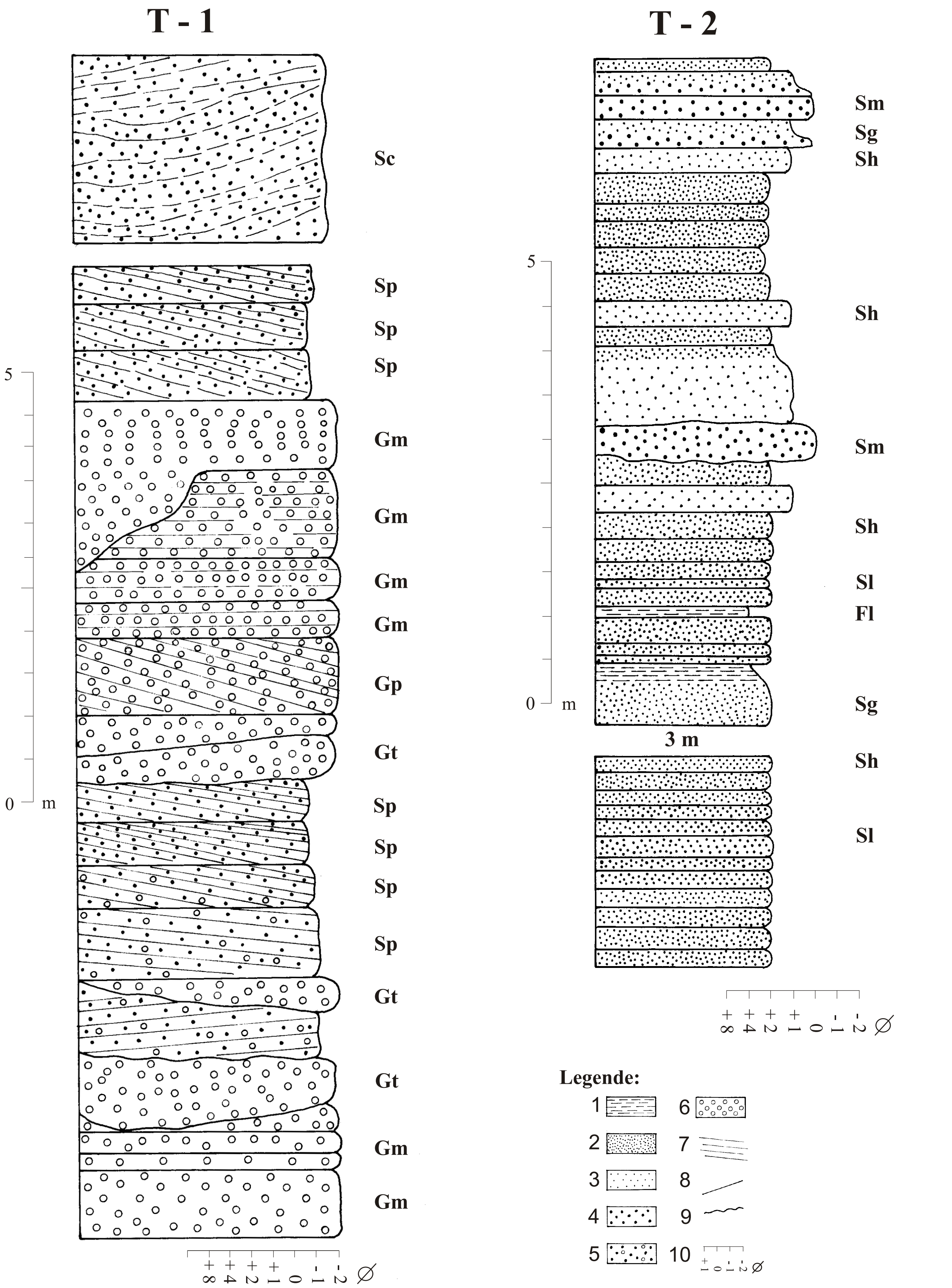

Fig. 1. Characteristic lithofacies in basal part of the Lower Triassic sequence (Locality Kostolný potok valley, SE from the Nemecká Village, Profiles T 1, T 2). Facial codes after Miall (1978).

Legend:

1. violet siltstone; 2. fine grained sandstone; 3. medium-grained sandstone; 4. corse-grained sandstone; 5. very coarse-grained sanstone; 6. fine-grained conglomerate with grain-supported structure; 7. current lamination; 8. sharp contact; 9. erosive contact; 10. grain size in ø scale