HIGH RESOLUTION PALEOBOTANY AND SEDIMENTOLOGY OF THE STEIERDORF FORMATION, RESITA BASIN

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The Steierdorf Formation (Bucur, 1991, 1997, Popa and Van Konijnenburg – Van Cittert, 2006) includes continental deposits represented by conglomerates, sandstones, clays and coal seams, yielding a highly diversified and preserved coal generating, fossil flora. The depositional conditions of the Steierdorf Formation were characterized by intramontaneous depression features, without marine influences. The age of the Steierdorf Formation is Hettangian-Sinemurian, with two members: The Dealul Budinic Member (basal Hettangian) and Valea Tereziei Member (Hettangian – Sinemurian). Initially (Bucur, 1991, 1997), the Steirdorf Formation was considered as including also a third, upper member, the Uteris Member, represented by bituminous black shales, Pliensbachian – Middle Toarcian in age, deposited in deep lagoonal conditions with marine influences (marine invertebrates and vertebrates). In this paper, as Popa and Van Konijnenburg – Van Cittert (2006) suggested, the Uteris Member is separated of the Steierdorf Formation and given a distinct status, the Uteris Formation. The facies and genetic features of the Steierdorf and Uteris Formations are indeed distinct, making them two separate stratigraphic units.

Based on the fossil flora, the Steierdorf Formation is characterized by two biostratigraphic units, the Hettangian *Thaumatopteris brauniana* taxon range Zone and the Sinemurian *Nilssonia* cf. *orientalis* assemblage Zone (Popa, 2000a). The high diversity of the flora, surpassing 120 taxa, includes all Early Jurassic terrestrial plant groups, such as bryophytes, pteridophytes and gymnosperms. Animal bioturbation, such as tetrapod tracks and vertebrate burrows was also recorded (Popa, 2000b, Popa and Kedzior, 2006). Typical coal generators were *Schizoneura carcinoides*, associated with *Equisetites* div. sp., all of them swamp dwelling plants. Subsequent coal generators were bennettites (*Zamites schmiedelii*, *Z. andraeanus*, *Z. aninaensis*, etc.), ferns (*Cladophlebis denticulata*) and even ginkgoaleans (*Ginkgo skottsbergii*), occurring in the swamp areas as these areas were in the process of being filled with sediment and closed. Swamp edges plants were conifers (*Podozamites paucinervis*, *P. distans*, *Brachyphyllum* sp., etc.), and seed ferns (*Pachypteris rhomboidalis*, *P. speciosa*, *Komlopteris nordenskioeldii*). The flood plain plants were mainly represented by ferns (*Aninopteris formosa*, *Coniopteris hymenophylloides*, *Cladophlebis denticulata*, *Dictyophyllum irregularis*, *D. nilssonii*, etc.), cycads (*Nilssonia* cf. *orientalis*, *Ctenis grandis*, etc.), and bennettites (*Zamites* div. sp., *Pterophyllum* div. sp., *Ptilophyllum ptilum*, etc.). A possible upland flora included czekanowskialeans (*Czekanowskia rigida*, *Phoenicopsis angustifolia*, etc.). All these high resolution plant assemblages can now be correlated with high resolution sedimentological data, for a detailed correlation and paleoecological reconstruction with respect to various stratigraphic levels and surface distribution within coeval stratigraphic levels.

The Steierdorf Formation outcrops mainly in Anina (part of which was formerly named Steierdorf) and in Doman. Anina is the locality with the best outcrops of both members of the Steierdorf Formation, and the place where the Ponor and the Czech

Colony quarries occur. These two quarries offer the best working conditions for high resolution sedimentology and paleobotany since the closure of the underground mining horizons opened by the Pits no. 1, 2 and 4, in 2006. These quarries were intensively worked by the authors since 2005 for sedimentology and paleobotany, in order to correlate in detail the depositional and paleobotanical data. These quarries, together with the sterile dump of the Pit 1 (northern Anina), represent the core of a future geopark. The quality of outcrops and the possibility to understand in detail the sedimentary structures, together with their associated plant remains, make them a unique window in the geological past.

Within the Dealul Budinic Member (basal Hettangian), at the base of coal-bearing succession, the coarse-grained sediments consist of mainly matrix-supported conglomerates and coarse-grained sandstones. These deposits are mainly massive, sometimes with large scale cross stratification. On the topmost surfaces of sandstone beds, oval blocks with secondary ferrooxide crusts occur, showing evidence of desiccation. The fine-grained sediments (mudstones and claystones) occur subordinately, generating thin horizontally laminated layers within coarser members. Additionally, in the upper part this sequence, a fireclay horizon is now reported. All deposits of this "red beds" sequence lack of plant fossils, only trace fossils being visible on the bedding surfaces. The red tint of this sequence, on the base of the latest observations, seems to be secondary in origin.

The occurrence of the layers of massive coarse-grained sediments with dispersed pebbles, mainly matrix-supported type, is an indicator for high viscosity flow, typical for alluvial fans. The sedimentary structures visible in the sandstone layers are an indicator for low viscosity flow. Large scale cross stratification and clasts imbrications suggest sheet flood deposits or stream channel deposits. Assuming all these features, the alluvial fan environment has been now recognized. However, red colours cannot be conclusive for climatic conditions. The occurrence of abundant sheet sandstone deposits, from several centimetres to a few metres thick, with abundant evidence of desiccation, interbedded with fine-grained playa deposits, can be considered as ephemeral, flash-flood sedimentation in arid to semi-arid conditions.

The coal-bearing sequence at the upper part of the Dealul Budinic Member and within the entire Valea Tereziei Member, is composed mainly of sandstone and conglomeratic layers and subordinately with mudstones, claystones and phytogenic material as well. The deposition of the coarsest members usually was preceded by erosion. On the erosional surfaces occur thick sandstone bodies, cross-bedded in large scale or massive conglomerates. The sandstone layers occurring within fine-grained deposits are strongly bioturbated by roots when they are covered by fine-grained clastics. Drifted logs are abundant and orientated parallel with dip of the strata. The fine-grained sediments attain less thickness. They contain coalified plant remnants and roots traces. The phytogenic sediments make thin (up to 20 cm) seams. The remnant of burnt coals has been observed and this level can be regarded as an additional correlative horizon, known in the all parts of the Ponor and Czech Colony quarries.

The coal-bearing sequence represents more humid conditions in comparison with underlying strata. These conditions favourable for peatbogs development, arisen on the overbank areas of the fluvial depositional system. The occurrence of the thick complex conglomerate-sandstone packages in the basal part of the coal-bearing succession, thick conglomeratic members and slight content of the overbank fines, suggest a deposition within a braided channel tract. The characteristic set of the sedimentary structures in the basal part shows similarities with deep, gravel-bed braided river of the Donjek type. The

upward decreasing amount of the coarsest fraction, substituted mainly by fine-grained sandstones and overbank fines indicates lowering currents strength.

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