

THE ANINA GEOPARK: PRESERVING THE GEOLOGICAL HERITAGE OF THE SOUTH CARPATHIANS

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Abstract. The geological heritage of the South Carpathians is exquisitely represented by the unique outcrops of the central area of the Reșița Basin (Reșița-Moldova Nouă sedimentary zone), grouped mainly around the Anina (Steierdorf) fossil-Lagerstätte locality, a former coal mining center with highly significant industrial architecture and historical heritage. Mesozoic sediments, outcropping in natural outcrops, open cast mines and colliery tips, yielding highly preserved and rich plant and animal fossils, permit unique paleontological and paleoecological studies. Such exceptional outcrops and colliery tips, together with the former coal pits and historic industrial compounds, deserve intense preservation under the framework of a future geopark, increasing the natural preservation and the economical potential of the Anina town.

Key words: Geological heritage, Anina Geopark, Reșița Basin, South Carpathians, Romania.

Résumé. L'héritage géologique des Carpates du Sud est particulièrement bien représenté par les affleurements de la région centrale du bassin de Reșița (zone sédimentaire de Reșița-Moldova Nouă) qui sont principalement regroupés autour du gisement fossile de Anina (Steierdorf), une ancienne mine de charbon faisant parti du patrimoine historique et culturel de la région. Les sédiments du Mésozoïque, affleurant naturellement au niveau des sections, ainsi que les carrières et gisements charbonneux contenant des fossiles de plantes et d'animaux extrêmement bien conservés, permettent des études paléontologiques et paléobotaniques à la fois uniques et cruciales pour cette période. La préservation exceptionnelle des fossiles au niveau des affleurements et des gisements de charbon ainsi que l'histoire et le patrimoine associés à la mine méritent d'être préservés au sein d'un futur géoparc qui permettrait en préservant son patrimoine historique et culturel d'accroître le potentiel économique de la ville d'Anina.

Mots-clés: patrimoine géologique, géoparc Anina, Bassin de Reșița, Carpates Meridionales, Roumanie.

INTRODUCTION

Anina (Steierdorf) locality is a former coal mining center for Lower Jurassic bituminous coals belonging to the continental Steierdorf Formation (Bucur, 1991, 1997, Popa and Kedzior, 2008), extracted from underground mines as well as from various quarries. Lower Jurassic black bituminous shales belonging to the Uteriș Formation (Bucur, 1991, 1997, Popa and Kedzior, 2008) were also extracted from the same mines. Anina occurs in the central area of the Reșița Basin (Reșița-Moldova Nouă sedimentary zone), Getic Nappe (Murgoci, 1905, Săndulescu, 1984). Due to its highly diverse and well preserved Early Jurassic plant fossils and vertebrate tracks and burrows, Middle to Late Jurassic and Early Cretaceous marine invertebrates and algae, Anina is a fossil Lagerstätte locality which deserves attentive preservation within the frame of a future geopark. Popa (2001, 2005) emphasized the exceptional paleobotanical heritage values of the Anina area, focusing on the Early Jurassic flora preserved there.

The Lower Jurassic (Hettangian-Sinemurian) Steierdorf Formation includes alluvial, fluvial and lacustrine deposits, represented by conglomerates, microconglomerates, sandstones, clays and coals. It includes the Dealul Budinic and the Valea Tereziei Members, the second including the coal seams and the compressive flora, as well as the majority of tracks and traces. The Steierdorf Formation is overlain by the Uteriș Formation (Bucur, 1991, 1997, Popa and Kedzior, 2008), represented by fossiliferous black, bituminous shales, Pliensbachian-Middle Toarcian in age. The Middle Jurassic (Upper Toarcian-Callovia) Tâlva Zânei Formation (Bucur, 1991, 1997) includes extremely fossiliferous marls, followed by the entire Upper Jurassic and Lower Cretaceous succession of several marine, carbonate formations, such as Gumpina, Brădet, Valea Aninei, Marila, Crivina and Plopa Formations, ranging from deep marine to carbonate platform facies (Bucur, 1991, 1997).

The Early Jurassic flora of the Steierdorf Formation is a compressive, coal generating paleoflora represented by bryophytes, pteridophytes and gymnosperms, and it was known since the pioneering works of Foetterle (1850), Ettingshausen (1852) and Andrae (1855), followed by the papers of Semaka (1962), Semaka and Givulescu (1965), Givulescu (1998), Popa (2000a, b), Popa and Van Konijnenburg – Van Cittert (2006). To these fossils were added rich Early Jurassic vertebrate tracks produced by possible crocodylians and certain sauropods (Popa, 2000c, Pienkowski *et al.*, 2009) and burrows (Popa and Kedzior, 2006), together with frequent plant-insect interactions, invertebrate traces and burrows (Popa, 2009).

The Uteriș Formation yields invertebrates and drifted floral remains, while the Middle Jurassic Tâlva Zânei Formation includes extremely diverse and well preserved marine bivalves, gastropods, cephalopods, crustaceans, among other groups of invertebrates and drifted floral remains, including drifted logs (Lazăr *et al.*, 2004). The Upper Jurassic and Lower Cretaceous formations outcrop extensively on the western flank of the Anina Anticline, along the Ponor and Colonia Cehă open cast mines, as well as southwards and northwards, to Crivina, Marila and Gârliște and Celnic, respectively.

GEOLOGICAL AND PALEONTOLOGICAL HERITAGE

Cross bedded, fossiliferous and bioturbated red beds outcrop next to the former headquarters of the Ponor Quarry, this sequence being the oldest sedimentary sequence in Anina Anticline structure. These red beds were considered in the previous literature as belonging to the Permian core of the Anina Anticline. Its age is yet unclear, ranging from Lower Permian in its original sense, Upper Triassic to Hettangian. Popa (2000a, 2009) and Popa and Meller (2009) published detailed maps of the Anina area with former coal mining works, therefore such maps will not be repeated here, as well as logs and geological maps, such as that in Pienkowski *et al.* (2009).

The Dealul Budinic Member of the Steierdorf Formation outcrops ideally south of the Ponor Quarry, to the northern tip of the Tomini Trading perimeter (former Crivina power plant), next to the Burlui coal gallery still in operation today. It outcrops also in Ponor and Colonia Cehă open cast mines, recording alluvial features.

The Valea Tereziei Member has its stratotype along the Tereziei Valley, next to the Pit IV, recording channel fills. It has its best outcrops next to the Tomini Trading perimeter (former Crivina power plant), and especially in Ponor and Colonia Cehă quarries. Also, the sterile tips of the Pit I are extremely rich in fossil plants and therefore they deserve special protection. Actually, the Ponor and Colonia Cehă quarries, together with the sterile tips of the Pit I have to be enlisted as Sites of Special Scientific Interest (SSSI), providing the core of the future Anina Geopark.

The Uteriș Formation outcrops excellently in Ponor, Colonia Cehă and Hildegard quarries, all these open cast mines being opened especially for the extraction of the black bituminous shales. Hildegard open cast mine records almost only the Uteriș Formation and today is partially covered by rooted soil. A classic outcrop is along the Tereziei Valley, on the Steierdorf – Uteriș road in Anina.

This formation is very fossiliferous, the fossils occurring both in the bituminous shales as well as in the interlayered siderite concretions.

The Tâlva Zânei Formation outcrops from Tomini Trading perimeter (former Crivina power plant) northwards, to Ponor and Colonia Cehă quarries. It outcrops almost continuously along this alignment (Anina Anticline's western flank), making of this formation one of the most well outcropped, most accessible and fossiliferous formations in Anina. Its northern outcrops, such as those next Tereziei Valley or those close to the Anina football stadium yield a rich crustacean assemblage, the remains being preserved in carbonate concretions. The formation outcrops excellently along the Anina-Reșița road, being also very fossiliferous.

The Gumpina Formation is well outcropped in Ponor (especially in the Zânei Hill, west of the quarry) and Colonia Cehă quarries, and also along the Pit IV-Brădet road, marked characteristically by large siliceous concretions. The Brădet Formation is outcropped in the Bibel Quarry, within the Brădet structure, west of Uteriș. The following marine carbonate formations (Crivina, Marila, etc.) outcrop ideally along the Anina valley, north of Celnic neighborhood and Pit I in Anina, especially along the Anina-Oravița railway, where their limestone induces a high energy relief.

Early modern *Homo sapiens* fossils were collected from a cave (Trinkhaus *et al.*, 2003) in the area, therefore increasing the significance of the paleontological heritage in the area.

MOBILE PALEONTOLOGICAL HERITAGE VALUES

Significant Early Jurassic plant collections from Anina are curated in Bucharest (University of Bucharest and the Geological Museum – Geological Institute of Romania), Cluj-Napoca (Babeș-Bolyai University), Timișoara (Banat Museum), Reșița (Reșița Museum), as well as in Anina (saved from destruction in Anina's Pit I). Abroad, important collections are curated in Vienna (Geological Survey of Austria), Budapest (Natural History Museum and Geological Survey) and Berlin. A detailed discussion over these collections was given by Oarcea and Semaka (1962), Popa (2000a, 2009) and by Popa and Meller (2009). The collection found in 2009, abandoned in Anina's Pit I, belonged to a larger historical collection begun by Austrian miners, the hand specimens still bear the original record numbers, but any other written records are still missing. This collection was surveyed by Oarcea and Semaka (1962), but the remains found in 2009 include less hand specimens.

CULTURAL HERITAGE

Coal mining in Anina began in 1792, when the first coal seams were discovered. The coal mines multiplied for 200 years, the mining activities reaching almost a total halt in 2006. Today, only few, single galleries are still in function, maintained by private operators. Several mining pits were saved from destruction, one of the best preserved compounds being the Pit IV, next to the Tereziei Valley. The most important mining complex, Anina's Pit I, occurring in northern Anina, suffered severe damage and vandalism after the mine was closed. There, as well as in the case of Pit II and IV, the Austrian industrial architecture is excellently preserved, with stone built compounds. Pit I was the access point to Anina North, Zona Nouă and Brădet coalfields, this intricate mining complex reaching even 1300 m depths along its 11th mining horizon. The Pit I was one of the deepest pits of Europe, and it was closed in 2006, after a fatal accident. The Pit I complex recorded a coal extraction complex, a coal washing and shipping complex, technical facilities as well as offices and mining headquarters, including even medical facilities. Its unnecessary closure induced the devastation of the complex, although the iron structures of the pit are still in place, with an uncertain future. Important industrial buildings with Austrian style architecture are still preserved along the Tereziei Valley, next to Pit IV,

as well as next to Pit II. The Anina town still preserves factory buildings with the same architecture. Also, worthwhile to note is Anina's railway station, a building bearing the classic Austrian architectural style.

PERSPECTIVES

The concept of a geopark for the Anina area proves to be the ideal solution for preserving its highly valuable geological heritage. A geopark in Anina area also links the geological heritage with local economical interests, therefore increasing the economy of the local community. Unfortunately, the immediate economical interests generated the unwise devastation of the former mining industrial complexes, as well as a doubtful land use for Ponor and Colonia Cehă quarries, true geological gems in terms of paleontological and geological heritage, inevitably and sadly transformed in polluted garbage dump sites. A geopark in Anina will increase the local identity and will serve for the better education of locals as well as of its visitors. A local natural history museum in the Steierdorf neighborhood, as proposed by the town hall, will be also added to the key sites of the area, such as the Ponor and Colonia Cehă quarries, and Pit I sterile dumps. The key sites of Ponor and Colonia Cehă quarries and Pit I sterile dump deserved strict scientific preservation as Sites of Special Scientific Interest (SSSIs – “rezervații paleontologice” in Romanian language). Historical sites, such as Pit I, Pit IV and Pit II are naturally linked to the geological values, proving that both geological and historical heritage generate valuable economical assets for the local community.

CONCLUSION

A geopark, including the Ponor and Colonia Cehă open cast mines and Anina's Pit I colliery tips as Sites of Special Scientific Interest (SSSIs) for its core sites, proves to be the ideal solution for preserving the geological heritage and for increasing the economical potential of the area. The valuable industrial compounds related to coal extraction in Anina add fundamental values to the geopark, increasing the historical and travel significance of the area.

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REFERENCES

- Andrae, C. (1855), *Beitrage zur kenntniss der fossilen Flora Siebenburgens und des Banates*. Abhandlungen der K. K. geologischen Reichsanstalt, **III** (4): 1–48.
- Bucur, I.I. (1991), *Proposition pour une nomenclature formelle des dépôts paléozoïques et mésozoïques de la zone de Reșița-Moldova Nouă (Carpathes Meridionales, Roumanie)*. Studia Universitatis Babeș-Bolyai, Geologie, **XXXVI** (2): 3–14.
- Bucur, I.I. (1997), *Formațiunile mesozoice din zona Reșița-Moldova Nouă*, Cluj-Napoca, 214 p.
- Ettingshausen, C. (1852), *Über die fossilen Pflanzen von Steierdorf in Banat*. Jb. K.K. geol. R.A. **III** (verh), 194: 1.
- Foetterle, F. (1850), *Verzeichniss der an die K.K. geologische Reichsanstalt gelangten Eisendungen von Mineralien, Petrefacten Gebirgsarten u.s.w.* Jahrbuch der kaiserlich-königlichen geologische Reichsanstalt, **1**(2): 350–358.
- Givulescu, R. (1998), *Flora fosilă a Jurasicului inferior de la Anina*. Editura Academiei Române, București, 90 p.

- Lazăr, I., Barbu, V. and Popa, M.E. (2004), *Contributions to the Middle Jurassic of the Anina area – the bivalve fauna* (part I). Acta Palaeontologica Romaniae: 233–246.
- Murgoci, G.M. (1905), *Sur l'existence d'une grande nappe de recouvrement dans les Carpathes meridionales*. C. R. Acad. Sci., 7: 31.
- Oarcea, C. and Semaka, A. (1962), *Flora Liasică din colecția de la Anina*. D.S. Com. Geol., **XLVI**: 239–244.
- Pienkowski, G., Popa, M.E. and Kedzior, A. (2009), *Early Jurassic sauropod footprints of the Southern Carpathians, Romania: palaeobiological and palaeogeographical significance*. Geological Quarterly, **53**(4): 461–470.
- Popa, E., Năstăseanu, S. and Antonescu, E. (1976), *Nouvelles données concernant la biostratigraphie du Jurassique inférieur de la zone de Sirinia (Banat)*. Dări de seamă ale ședințelor, **LXIII**(4): 7–24.
- Popa, M.E. (2000a), *Aspects of Romanian Early Jurassic palaeobotany and palynology*. Part III. *Phytostratigraphy of the Getic Nappe*. Acta Palaeontologica Romaniae, 2: 377–386.
- Popa, M.E. (2000b), *Early Jurassic land flora of the Getic Nappe*, University of Bucharest, Ph. D. thesis, Bucharest, 258 p.
- Popa, M.E. (2000c), *First find of Mesozoic tetrapod tracks in Romania*. Acta Palaeontologica Romaniae, 2: 387–390.
- Popa, M.E. (2001), *Ponor SSSI (Site of Special Scientific Interest). Lower Jurassic Paleoflora*, in: I.I. Bucur, Filipescu, S., Săsăran, E. (Editor), *Algae and carbonate platforms in western part of Romania. Field trip guidebook*. Babes-Bolyai University, Cluj-Napoca, pp. 167–171.
- Popa, M.E. (2005), *Aspects of Romanian Early Jurassic Palaeobotany and Palynology*. Part VI. *Anina, an exceptional locality*. Acta Palaeontologica Romaniae, 5: 375–378.
- Popa, M.E. (2009), *Late Palaeozoic and Early Mesozoic continental formations of the Reșița Basin*. Editura Universității din București, Bucharest, 197 p.
- Popa, M.E., Kedzior, A. (2006), *Preliminary ichnological results on the Steierdorf Formation in Anina, Romania*. In: Z. Csiki (Editor), *Mesozoic and Cenozoic vertebrates and paleoenvironments*, București, pp. 197–201.
- Popa, M.E., Kedzior, A. (2008), *High resolution paleobotany and sedimentology of the Steierdorf Formation, Reșița Basin*, in: I.I. Bucur and S. Filipescu (Editors), Annual scientific session “Ion Popescu Voitești”, Cluj University Press, Cluj-Napoca, pp. 57–59.
- Popa, M.E., Meller, B. (2009), *Review of Jurassic plants from the Anina (Steierdorf) coal mining area, South Carpathians, in the collections of the Geological Survey of Austria*. Jahrbuch der Geologischen Bundesanstalt, **149**(4): 487–498.
- Popa, M.E., Van Konijnenburg-Van Cittert, J.H.A. (2006), *Aspects of Romanian Early – Middle Jurassic palaeobotany and palynology*. Part VII. *Successions and floras*. Progress in Natural Sciences, **16**: 203–212.
- Semaka, A. (1962), *Flora Liasică de la Anina (Banat)*. Anuarul Comitetului Geologic, **XXXII**: 527–569.
- Semaka, A., Givulescu, R. (1965), *Flora Fossilis Rumana. Catalogus genera et species plantarum*. Palaeontographica Abt. B, **116**(1–4): 55–122.
- Săndulescu, M. (1984), *Geotectonica României*. Editura Tehnică, București, 336 p.
- Trinkhaus, E., Moldovan, O., Milota, Bilgăr, A., Sarcina, L., Athreya, S., Bailey, S.E., Rodrigo, R., Gherase, M., Higham, T., Bronk Ramsey, C., Van der Plischt, J. (2003), *An early modern human from Peștera cu Oase, Romania*. PNAS, **100**(20): 11231–11236.

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