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The Gamila Peak Spherical Concretions and the Oxia Hanging Valley at the Vikos-Aoos Geopark

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Vikos-Aoos Geopark is part of the European and Global Geopark Networks of UNESCO since 2010 and it is located at the NW part of the Pindus Mountain Range at Epirus Region, northwestern Greece. The Geopark extends in an area of 1.200 km^2 from the area of Northern Pindus National Park to the Greek-Albanian borders. The area is characterized by a mountainous continuous and rugged terrain which is interrupted by steep gorges, elongated narrow valleys, and alluvial plains. Smolikas (Geros peak: 2637 m a.s.l.) and Tymfi (Gamila peak: 2497 m a.s.l.) Mountains host the highest peaks of the Geopark, while Vikos and Aoos Gorges as well as Konitsa plain control the lower relief morphology. Except of the major geological, geomorphological, and natural aspects, the Geopark hosts also significant cultural aspects. Sixty one traditional settlements belonging to the municipalities of Zagori and Konitsa, most of which are protected culturally and architecturally, are found within the Geopark area. These settlements bear a total population of 9954 inhabitants (Hellenic Statistical Authority, 2018). Nevertheless, 6362 of these inhabitants reside at Konitsa town, thus the Geopark area could be characterized as depopulated (Telbisz et al., 2019). In these publication we further discuss on the special geological aspects of the Vikos-Aoos Geopark, the Gamila peak spherical concretions and the Oxia hanging valley which are located at the Tymfi mountain massif, based on the recent publications made by authors (Chatzipetros and Stergiou, 2016; Telbisz et al., 2019).

The Tymfi mountain massif belongs to the Ionian geotectonic Zone of Greece. Jurassic to Cretaceous dolomites and limestones, Cretaceous to Upper Eocene limestones, and the Upper Eocene to Lower Miocene flysch formation characterize the local stratigraphy. Plenty of chert intercalations are found within the dolomites and the limestones as beds or as nodules. These sedimentary series constitute a continuous stratigraphy which is largely exposed due to the Vikos and Aoos Gorges incisions at the Tymfi anticline. The S-SW tilting, low-angle anticline of Tymfi has a NNW-SSE axial direction and it was formed under the Paleogene-Neogene folding and the later structural reconstruction of the area by ENE-WSW trending faults (Astraka and Konitsa faults) (Galanakis et al., 2007; Chatzipetros and Stergiou, 2016). Along with the structural features, an old glaciokarst and an active karst system had actively shaped the geomorphology of the Tymfi mountain massif since Pliocene resulting in a well karstified mountainous terrain. Voidomatis River constitutes the tributary where large amounts of subsurface and surface waters are drained.

The Gamila peak spherical concretions were described for the first time by Telbisz et al. (2019) (Fig. 1). They are found on the pathway (approximately at 2100 m a.s.l.) to Gamila peak in large collapsed rocky scraps, in limestone boulder sections or as boulders. They have spherical to elongated shapes ranging in diameter from 0.10 to 1 m and concentric zones. These zones are made of alternating fine-grained siliceous material and carbonate cement enriched in bioclastic material. Microscopic study revealed that the matrix of the concretions is both carbonatic and siliceous (Telbisz et al., 2019). Regarding their formation it could be suggested that their diagenesis is characterized by an early and imperfect carbonate cementation, and by a simultaneous massive precipitation of SiO_2 in the intergranular space. Although that the origin of the SiO_2-rich solutions is yet unknown it may be assumed that their origin is the dissolute siliceous bioclasts and to a lesser extent some external fluids enriched in SiO_2-rich (Telbisz et al., 2019). Concretions of various sizes and shapes are found worldwide in different sedimentary rock types. The Gamila peak spherical concretions resemble to the spherical concretions found at Lower Eocene Drunka limestone formation at Egypt. Nevertheless, their complete mineralogical, geochemical and genesis interpretation needs further investigation.

Limestone pavements, shafts, and remnants of moraines and periglacial rock glaciers found in large U-shaped depressions and in higher cirques characterize the glaciokarst morphology (Waltham, 1978; Telbisz et al., 2019). Based on the description of these features Hughes et al. (2007) identifies three glacial stages; an early plateau glacier and outlet glaciers stage, a middle cirque and valley glaciers stage, and a third cirque glaciers stage. These stages are dated respectively at 430 ka BP, at 140 ka BP, and at 110 ka BP (Hughes et al., 2007). The Oxia hanging valley is another remnant of the glaciokarst of Tymfi. It was identified by Chatzipetros and Stergiou (2016) and mapped by using an Unmanned Aerial Vehicle (Fig. 2). The aerial scans covered the entire length of the valley, as well as its exit to the Vikos Gorge. The valley has a total length of 3.24 km and runs across the western part of the Tymfi mountain massif in a SW-NE direction. Eocene limestones form the lithological basement of the valley. The surrounding geomorphology is characterized by a typical karst plateau and several tributaries draining this plateau end at the valley. The valley starts at 1332 m a.s.l. in a slightly uplifted block of the mountain massif and exit to Vikos Gorge approximately at 1305 m a.s.l. after covering approximately 3.20 km of distance. The exit of the valley has a U-shape and it is located approximately at 670 m above the bed of the gorge. From the other side of the uplifted block and towards SE there is another V-shaped valley (1.9 km in length) starting at 1327 m a.s.l. and ending approximately at 1000 m a.s.l. near Ano Pedina village.

Figure 1. A fractured spherical concretion in a limestone boulder section on the pathway to Gamila peak (Photo: T. Telbisz).

Figure 2. An aerial photograph taken by the DJI Phantom 3 Professional UAV which was used to scan the Oxia hanging valley. A dashed line highlights the exit of the hanging valley to Vikos Gorge. (Photo: A. Chatzipetros).

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