Elements of hypogene origin in the karst caves of the Urals (Russia)

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Indications of hypogene karst are frequently observed in caves of the Urals. This paper provides a brief overview of them. The Urals occupy an immense territory which lies in four climatic zones and has a complex geological structure. The Urals region is divided into nine geographic areas based on geology, geomorphology, structure and tectonics. (Chibilev 2011, Shakirov, 2011)

Karst features have been studied as part of the natural zoning of the Urals region (Chibilev 2011). In the Urals, virtually all types of surface and underground karst features are present. Rock formations stretch longitudinally, that favors a comparative analysis of processes in karst landscapes in different latitudinal geographical zones. Extensive occurrence of soluble rocks through the area and in the geological cross- section in cratons, folded zones and troughs pre-determined karst development over the long geological history of the Urals. The most intense karstification occurs in Paleozoic sediments.

In the eastern margins of the East European Craton and adjacent parts of the Ural Foredeep, sulfate rocks (gypsum and anhydrite) intercalated with thin beds of limestone and dolomite of the Irenskaya Suite are karstified, and to a lesser extent-limestones and dolomites of the Filippovsky Unit of the Kungurian Stage and limestones of the Artinskian Stage of Lower Permian. Salt-bearing and sulfate sediments occur mainly in the Ural Foredeep. The folded zone of the West Ural and the Central Ural uplifts are characterized by karst development in the Devonian, Carboniferous and Permian carbonate strata of a total thickness of more than 2,000 m. The most intensely karstified is the western slope of the South Urals.

To the date, more than 3,200 caves with the total length of about 244 km are documented in the Urals. Morphological indications of hypogene origin are observed in cavities formed in confined aquifer systems due to the rising groundwater flow through the layers of soluble rocks, and in caves associated with zones of tectonic disruptions. Among suspected hypogene caves developed in carbonate rocks, the most representative are Kizelovskaya-Viasherskaya (7,600 m), Mariinskaya (1,000 m), Sukhaya Atya (2,130 m), Schumiha (1,240 m). Caves of the hypogene origin in sulfate rocks include Vertolyotnaya (1,770 m), Kungur Ice Cave (5700 m), and Ordinskaya (4,900 m).

The largest springs with rising flow (Pymva-Shor, Blue Lake, Kurgazak, Krasny Kluch, Sarva, Sakaska, Berhomut, Tyuba, among others) are associated with the margins of major hydrological basins. Outputs of deep saline waters (sometimes with a high helium content) are documented in the North Urals within the Ural Foredeep (Larevskie Springs), and in the South Urals within the Inzer Synclinorium (Assinsky Springs).
Hypogene hydrothermal cavities, genetically unrelated to the superficial karst topography and local surface recharge, were encountered during the development of the Kizel Coal Basin and the Severouralsk bauxite deposit at depths of more than 2 km.

Hypogene karst processes actively develop in regions underlain by sulfates, carbonates and salt formations throughout the Urals. Even though more than nine thousand publications have been written about the caves of the Urals, there are substantial gaps in understanding of karst evolution such as water exchange conditions, climate, geomorphologic and tectonic history of the territory, and transformation of the soluble formations. Hydrodynamic conditions of confined and unconfined aquifers are ultimately reflected in the morphology of conduits and cavities forming in rocks. Nowadays, we are in the initial stage of the recognition and interpretation of hypogene karst processes and features in the Urals, and further studies are needed to reveal their actual distribution and importance.

REFERENCES

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