

hardness testing and time-lapse photography. Such a field experiment approach provides an ideal way of testing links between climatic and environmental variables and stone deterioration and validating output from numerical modelling approaches (such as Hydrus, which has been used in this project). Further observations of moisture regimes and decay features have been made from CWG stones within cemeteries near our experimental sites.

Hand held resistivity and capacitance probe surveys, in conjunction with electrical resistance tomography, provide detailed, spatially-resolved data on moisture distributions which can be compared with mapping of the nature and severity of decay and monitoring of surface water patterns from time-lapse photography. Here we show direct evidence of damp conditions (both surficial and deep-seated) at the base and top of gravestones, associated with two types of deterioration, with a drier central area characterised by less weathered stone. Decay surveys indicate extensive surface damage within the upper parts of the gravestones, and considerably less damage below this.

## **The structural-metallogenic maps of ore districts of F.Y.R.O. Macedonia**

Volkov A. V.<sup>1</sup>, Serafimovski T.<sup>2</sup>, Alekseev V. Yu.<sup>1</sup> and Tasev G.<sup>2</sup>

<sup>1</sup>*Institute of geology of ore deposits, petrography, mineralogy and geochemistry of the Russian Academy of Science, IGEM RAS*

*119017, Staromonety per., 35, Moscow, Russia, tma2105@mail.ru*

<sup>2</sup>*University "Goce Delcev"- Stip, faculty of natural and technical sciences of Institute of Geology, Goce Delcev 89, 2000, Stip, F.Y.Republic of Macedonia, todor\_s2000@yahoo.co.uk*

The metallogenic characteristics, tectonic setting, and structure of F.Y.R.O. Macedonian territory, Kozuf-Aridea and Kadica-Bucovic ore districts and its specific formation features are discussed in this paper on the basis of new results and data obtained by previous investigations. The interpretation of satellite images and morphostructural analyses were employed successfully for revealing the ore-concentrating structural features. The tectonic elements of the present-day topography were marked out and compared with the structural features that existed during the period of ore formation. The use of the present-day structural landforms of F.Y.R.O. Macedonia for reconstruction of the tectonic elements of ore-bearing periods became possible after substantiating their inherited evolution. The ring structure occupies a special position in southern F.Y.R.O. Macedonia and ore districts are controlled. Geological, geochemical, and morphostructural attributes allow interpretation of this structure as a center of long-term endogenous activity that evolved since the Jurassic-Cretaceous time.

## **Cretaceous magmatic evolution of the Srednogorie Zone (Bulgaria) and the continuous evolution into the Rhodopen Massif (Bulgaria, Greece)**

von Quadt A.<sup>1</sup>, Peytcheva I.<sup>1,2</sup>, Sarov St.<sup>3</sup> and Heinrich C.A.<sup>1</sup>

<sup>1</sup>*Institute of Geochemistry and Petrology, ETH Zurich, Clausiusstr. 25, Switzerland, vonquadt@erdw.ethz.ch*

<sup>2</sup>*Geological Institute, Bulgarian Academy of Science, 1113 Sofia, Bulgaria, peytcheva@erdw.ethz.ch*

<sup>3</sup>*Research Institute "Geology and Geophysics" Corporation, 23 Sitnyakovo Blv., 1505 Sofia, Bulgaria*

The Apuseni–Banat–Timok–Srednogorie (ABTS) belt of extensive calc-alkaline magmatism and Cu–Au mineralization is related to the subduction of the Tethys ocean beneath the European continental margin during the late Cretaceous time. Major economic porphyry-style and high-sulphidation ore deposits are restricted to certain segments along the belt and are aligned on the Panagyurishte corridor (Central Srednogorie) in Bulgaria and the Timok region in Serbia. The present study reviews the geology, geochemistry and geochronology of igneous events in the Srednogorie/Timok Zone, some features of the related Cu-Au mineralization and the continuous magmatic evolution to the South (Rhodope Masif).

The Srednogorie Zone (central and eastern part) revealed U–Pb zircon dates from subvolcanic intrusions and major plutons, supplemented by published Ar–Ar and Re–Os age data for the hydrothermal ore deposits, a general younging of magmatism from  $92.1 \pm 0.25$  Ma in the north (Elatsite deposit) to  $78.53 \pm 0.15$  Ma in the south (Capitan Dimitrievio pluton). The Timok region shows the starting point of the magmatism at 90–86.6 Ma and to end with the intrusion of plutons about 82–78 Ma (see Moll et al., 2010, this volume). Economic Cu–Au mineralizations in both sections are related to subvolcanic/ volcanic suites and are dated in the range of 92 to 86 Ma in Bulgaria and mainly about 86–84 Ma in the Timok zone. The age progression correlates in two profiles (Central-Eastern Srednogorie) with an isotope-geochemical trend (Sr–Nd, Hf–zircon data) of decreasing crustal input into mantle-derived magmas. The age and geochemical trends are explained as a consequence of slab retreat during oblique subduction.

The Cretaceous magmatism continues into the Rhodope Massif. The western Rila batholith gives a zircon age of  $69.26 \pm 0.26$  Ma and a granite at the western border of the Rila batholiths an age of  $61 \pm 1.5$  Ma (LA-ICPMS) which are interpreted as the time of emplacement; NW of Dospat an U/Pb zircon age of  $77 \pm 1.3$  Ma and further to south at Elatia-Barutin the zircon dating show magmatic age of  $55.93 \pm 0.28$  Ma. The  $\epsilon$ -Hf characteristics change from the border Srednogorie Zone/Rhodope Massif of +10 (T-80 Ma) to +2–6 in the central part of the RM and to +1–3 (T-56Ma) at Elatia-Barutin. The crustal input of the Cretaceous/Tertiary magmatism increases to south which is documented by Sr–Nd isotope tracing data and the model of the slab retreatment (Srednogorie Zone) has to be change for the geodynamic interpretation.

## **Pilot study for artificial recharge of the South-Eastern Mesaoria Aquifer (Cyprus), using tertiary treated wastewater**

Voudouris K.<sup>1</sup>, Kaklis T.<sup>1</sup>, Constantinou C.A.<sup>2</sup>, Evaggelatos F.<sup>3</sup>, Papageorgiou S.<sup>3</sup>, Mentis A.<sup>4</sup>, Irakleous Th.<sup>2</sup> and Panagiotou Ch.<sup>5</sup>

<sup>1</sup>Laboratory of Engineering Geology & Hydrogeology, Department of Geology, Aristotle University of Thessaloniki, 54124 Greece, kvoudour@geo.auth.gr, kaklis@geo.auth.gr

<sup>2</sup>Geological Survey Department, Nicosia, Cyprus, cconstantinou@gsd.moa.gov.cy

<sup>3</sup>LDK Consultants, Athens, Greece, foe@ldkeco.gr, spa@ldkeco.gr

<sup>4</sup>Civil Engineering, PhD, <sup>5</sup>Envir. Sciences, Atlantis consulting, Cyprus

In many arid or semi-arid countries, like Cyprus, groundwater is the main source for domestic and irrigation use. The degradation of groundwater resource can be quantitative and qualitative, if the abstraction exceeds the natural recharge rate. For this reason treated water at these areas is a valuable water resource and should be taken into account in designing a rational water policy. Furthermore, the interest in artificial recharge of groundwater using pretreated waste water continues to increase, especially in the semi-arid countries. In this paper, the possibility of artificial recharge in the South-Eastern Mesaoria (Kokkinochoria) aquifer, close to Liopetri village, is examined. This study area is characterised by low precipitation (330 mm) and it is covered by deposits of Nicosia formation, Pliocene aged, which consists of marls and fined to coarse grained calcitic sandstone. The aquifer is developed between the sandstones horizons and sands. The average thickness of the aquifer is up to 80 m and the maximum 120 m. Overpumping during the last decades, through a large number of boreholes, has caused a decline of groundwater level and the occurrence of negative piezometry up to 30 m below mean sea level. As a result, sea intrusion phenomena are recorded for distance up to 1–2 km inland. Therefore, the use of tertiary treated wastewater, which is produced at Agia Nappa-Paralimni treatment plant, is proposed for the application of artificial recharge through boreholes. Adequate pretreatment of the reclaimed water is also considered prior to the recharge, taking into account the final use of the aquifer's water.