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Geophysical Investigation of Zerelia Twin-Lakes (Central Greece): Two Possible Meteorite Craters

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Two circular permanent lakes of 150 and 250m diameter and 6-8m depth to an unconsolidated muddy bottom occur 250 m apart from each other, isolated in the agricultural fields SW of the town of Almyros (Thessaly, central Greece) (Fig. 1) (Dietrich et al., 2017). Geological outcrops that exhibit possible underground structures are missing in the area. The age of the lakes is assumed to be Late Pliocene to Early Holocene with a minimum age of approx. 7000 years BP.

Figure 1. The Magoula Zerelia twin-lakes in the agricultural fields SW of the town of Almiros (Thessaly) with the hillsite of the prehistoric Magoula Zerelia settlement, which was occupied from the Middle Neolithic period until Late Bronze Age. Red stippled line mark the distribution of the "fallback breccia" as deposits due to the impact of the projects. SP 1 and 2 mark sampling points at small trenches within the walls of the fallback breccias.

The halo-type embankments of the lakes, excavated in two trenches down to 8 m depth, are made up of yellow to brownish, clay-rich and whitish marly soil with pedogenic characteristics and weak stratification. The southern parts of the halos contain angular and spherical clasts of various, up to decimeter size, which are made up of polymict, quartz-rich hard carbonate breccia with marly and calcite feathery, pseudospherulitic fibrous calcite to micro-sparitic textures, besides abundant quartz and chert fragments, as well as spheroidal shaped solidified, calcite veined "septariantype" carbonate clasts. The carbonatic matrix includes small xenomorphic phases, such as chromspinel, zircon with blurred granular and skeletal textures, skeletal rutile and ilmenite, which are interpreted as relicts of partial melting and quenching under high temperatures of 1240-1800°C. Only a few quartz fragments exhibit indistinct planar fractures. In several cases they include exotic Al-Si- and sulfur bearing Fephases, <1-10 mm as globules. The carbonaceous textures, small calcareous porcelain fragments and calcite globules in quartz are interpreted as possible carbonate melting, quenching, devitrification and recrystallization.

Geophysical Survey

A gravity survey was carried out in the area around the two lakes to form the Gravity Anomaly Field. About 80 gravity measurements were taken by the use of the LaCoste & Romberg G-496 gravity meter. The Gravity Anomaly Map of the area is presented in Figure 2. It was found that a surface density of about 2 gr/cm3 was appropriate to reduce the gravity anomaly values after fitting a 2nd and 3rd polynomial fit to the observed gravity anomaly field. It can be seen that two gravity lows are associated with the localities of the two lakes, reaching values of about 120 gravity units (gu). The modelled "Residual Gravity" profiles through the lakes indicate negative gravity anomalies of bowl-type structures down to 150 m for the eastern lake and down to 250 m for the larger western lake.

Total field magnetic measurements were also conducted to determine the Total Magnetic Field at an effort to detect magnetic anomalies relating to the probable presence of a magnetic body supporting the meteorite impact hypothesis. Total field magnetic readings were performed using total field magnetometers of the GEOMETRICS G-856 type along 12 profiles at a spacing of 10 m. Magnetic measurements were also taken peripherally around the two lakes. Corrections for the normal field and the diurnal variation were made to form the magnetic anomaly value for each station. As can be seen from the magnetic anomaly map (Fig. 2), the eastern part of the area, as well as the half northern and southern part

is characterized by positive anomalies, which should be attributed to the basement geological formations. The same positive feature extending N-S is the ridge separating the two lakes, forming actually a part of the basement. The two lakes are also associated with two magnetic anomalies. The eastern lake is dominated by a large negative magnetic anomaly encompassing even a region outside the lake. There is also another positive anomaly at its eastern flank, but this should rather be attributed to as part of basement characteristics. Magnetic readings have not been taken on the surface of the two lakes, so the values over them have been produced by the interpolation routine.

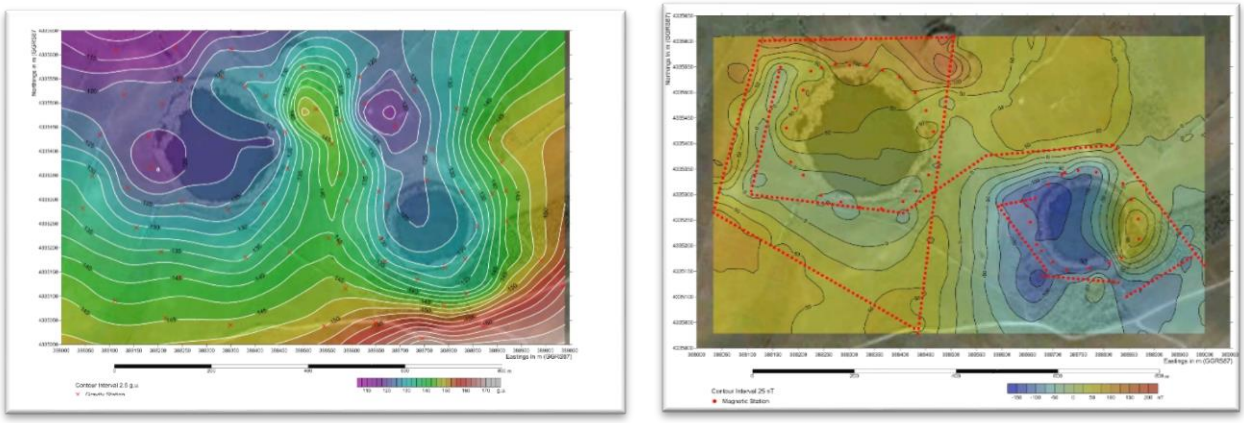

Figure 2. Gravity Anomaly Map referred to IGSN'71 and GRF'67 (Left) and Total Field Magnetic Anomaly Map (Right) superimposed on the Google Image.

The situation on the western lake is almost the same. A negative anomaly dominates its southern flank which swings to the west along its western part. However, most the lake is covered by positive anomaly values that have to be treated with caution since they are deduced by interpolation. Therefore, the magnetic anomaly map should only qualitatively be considered.

Discussion

Several hypotheses can be drawn upon to explain the origin of these enigmatic twin-lakes: a) Maar-type volcanic craters; b) Hydrothermal or CO_2/hydrocarbon and methane gas explosion craters, producing mud-volcanoes; d) Doline holes due to karstification; or e) Small meteorite impact craters, the latter being a plausible explanation due to geologic, petrologic, and geophysical evidence. However, an underground gas explosion cannot be excluded. The morphology and dimensions of the lakes, as well as the density contrast tomography of the bedrock favour a meteorite impact hypothesis of a projectile, which may has split into two fragments before reaching the surface.

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References

Dietrich, VJ., Lagios, E., Reusser, E., Sakkas, V., Gartzos, E., Kyriakopoulos, K., 2017. The Zerelia twin-lakes (Central Greece): Two Possible Meteorite Craters." LAP LAMBERT Academic Publishing. ISBN-13: 978-3-659-64693-5, 116p.