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Magnetic and gravimetric modeling of the Monchique magmatic intrusion in south Portugal

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The Monchique alkaline complex (MAC) crops out in southern Portugal with a roughly elliptical shape of about 80 km^2 elongated along ENE-WSW direction. The MAC dates to Late Cretaceous (69-72 Ma) and intrudes the Carboniferous Flysh formation of the South Portuguese Zone. At the surface, it comprises two main types of syenites: a central homogeneous nepheline syenite surrounded by a heterogeneous syenite unit, and some less expressive outcrops of mafic rocks (gabbros, hornfels, breccia and basalts). This igneous complex belongs to the Upper Cretaceous West Iberia alkaline magmatic event, characterized by alkaline magmatism of sublithospheric origin and active from approximately 100 Ma to 69 Ma.

The Monchique region hosts the most active seismic cluster of mainland Portugal, with low magnitude earthquakes (M < 4) that occur along lineations with NNE–SSW and WNW–ESE preferred orientation.

In this work we study the Monchique region through gravimetric and magnetic methods in order to: 1) better understand how the MAC influences the geomagnetic and gravimetric field in the region; 2) to create a new and consistent 2D and 3D model for the intrusion; and 3) to help constraining the origin of the observed seismicity and its possible relation with the existence of subcropping magmatic bodies.

We process recently acquired data - ground gravity survey (49 points) and drone-borne aeromagnetic survey – and integrate it with existing data. The interpretation of gravimetric results is complemented by density analysis of magmatic and host rocks. We perform 3D magnetic and gravity inversion to model the geometry of gravity and magnetic sources, and 2D magnetic forward modeling along a representative profile.

The calculated Bouguer gravity anomaly shows a positive gradient towards the southwest with a negative peak in the center of the Monchique mountain. However, when applied the terrain correction (complete Bouguer anomaly), this peak vanishes. This is justified by the similar mean

density values for the syenite and host rocks, respectively 2560 kg/m^3 and 2529 kg/m^3.

The new aeromagnetic data allows for mapping the Monchique magnetic anomaly with unprecedented detail and reveal a 10 km elongated anomaly with 30 m wavelength with maximum 1707 nT amplitude. 3D susceptibility inversion models show a 15km long body with maximum depth between 5-10km, and susceptibility >0.02 SI, in agreement with previous susceptibility analysis in the region. The highest magnetic signal is found at Picota hill (east), but the deepest parts of the intrusion seem to be bellow Foia hill (west). It is noteworthy that earthquake hypocenters concentrate at depths of 5-20 km, thus below most of the modeled magmatic intrusion.

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