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Estimation of the depth of faulting in the northeast margin of Argyre basin (Mars) by structural analysis of lobate scarps

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Lobate scarps are tectonic structures considered as the topographic expression of thrust faults. For this study we have chosen three large lobate scarps (Ogygis Rupes, Bosporos Rupes and a third unnamed one) located in Aonia Terra, in the southern hemisphere of Mars near the northeast margin of the Argyre impact basin. These lobate scarps strike parallel to the edge of Thaumasia in this area, showing a roughly arcuate to linear form and an asymmetric cross section with a steeply frontal scarp and a gently dipping back scarp. The asymmetry in the cross sections suggests that the three lobate scarps were generated by ESE-vergent thrust faults.
Two complementary methods were used to analyze the faults underlying these lobate scarps based on Mars Orbiter Laser Altimeter data and the Mars imagery available: (i) analyzing topographic profiles together with the horizontal shortening estimations from cross-cut craters to create balanced cross sections on the basis of thrust fault propagation folding [1]; (ii) using a forward mechanical dislocation method [2], which predicts fault geometry by comparing model outputs with real topography. The objective is to obtain fault geometry parameters as the minimum value for the horizontal offset, dip angle and depth of faulting of each underlying fault.
By comparing the results obtained by both methods we estimate a preliminary depth of faulting value between 15 and 26 kilometers for this zone between Thaumasia and Argyre basin. The significant sizes of the faults underlying these three lobate scarps suggest that their detachments are located at a main rheological change. Estimates of the depth of faulting in similar lobate scarps on Mars or Mercury [3] have been associated to the depth of the brittle-ductile transition.

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[3] i.e. Schultz and Watters (2001) Geophys. Res. Lett., 28, 4659-4662; Ruiz et al. (2008) EPSL, 270, 1-12; Egea-Gonzalez et al. (2012) PSS, 60, 193-198; Mueller et al. (2014) EPSL, 408, 100-109.