3D MODELING OF OGYGIS RUPES LOBATE SCARP, MARS

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Abstract

The study of the thrust faults that control lobate scarp formation provides information on the faulting processes and the mechanical behavior of the lithosphere at the time of formation. The 3D modeling of a lobate scarp expands the information of these compressive structures. This method provides an overview of the whole lobate scarp structure, identifying variations of the fault parameters and its relation with other subsidiary structures. The listric fault plane morphologies obtained are constrained by the shape of the uplifted relief. The depth-to-detachment of the main fault underlying Ogygis Rupes is set at 17-18 km while the subsidiary faults root at a shallower depth.

1. Introduction

Lobate scarps are structural landforms present in terrestrial planetary surfaces considered to be the topographic expression of large thrust faults. The modeling of lobate scarp topography allows us to approximate the structural parameters that define the underlying faults (dip angle, slip and depth of faulting). The depth of faulting of these large compressive structures on Mars is considered to be the brittle-ductile transition (BDT) at the time of lobate scarp formation during the Late Noachian-Early Hesperian, so their study provides insights on the lithospheric mechanical and thermal structure [e.g. 1, 2].

2. Ogygis Rupes

Ogygis Rupes is located in Aonia Terra, between the northwest margin of Argyre impact basin and Thaumasia Montes. This structure is formed by a large thrust fault verging SE, which is 220 km length and uplifts a relief of up to ~2200 m [3].

Two subsidiary faults defined as backthrusts are associated with the main thrust fault, presenting an opposite vergence (Fig. 1). The good preservation of this lobate scarp together with its topographic isolated structure that allow to easily identify it from the regional topography, make Ogygis Rupes a good candidate for 3D modeling.

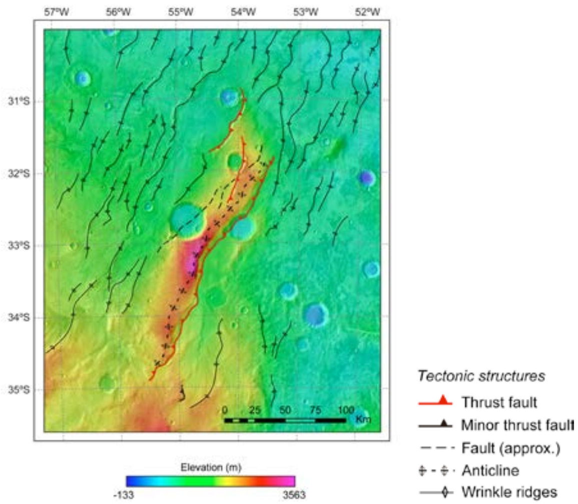

Figure 1. *Structural map of Ogygis Rupes region over the original MOLA surface.*

3. Methodology

The displacement of the hanging wall over the footwall is modeled using Fault Parallel Flow algorithms [4] while the folding associated with the fault propagation fold has been modeled using the Trishear method [5]. The combination of these algorithms during the 3D modeling [e.g. 6, 7] using MOVE™ software reproduces the original lobate scarp topography, extending the information about lobate scarps structure.

An initial surface restoring and later forward modeling have been performed to fit the model to the observed surface, allowing us to obtain the fault parameters (dip angle, depth of faulting, slip) and trishear parameters and its variations along length. Additionally, the modeling provides data about the interaction of the main thrust fault with other subsidiary structures, which cannot be obtained by 2D modeling methods.

4. Results and conclusions

The resulting 3D forward model is a good reproduction of Ogygis Rupes lobate scarp, presenting a low elevation difference when comparing

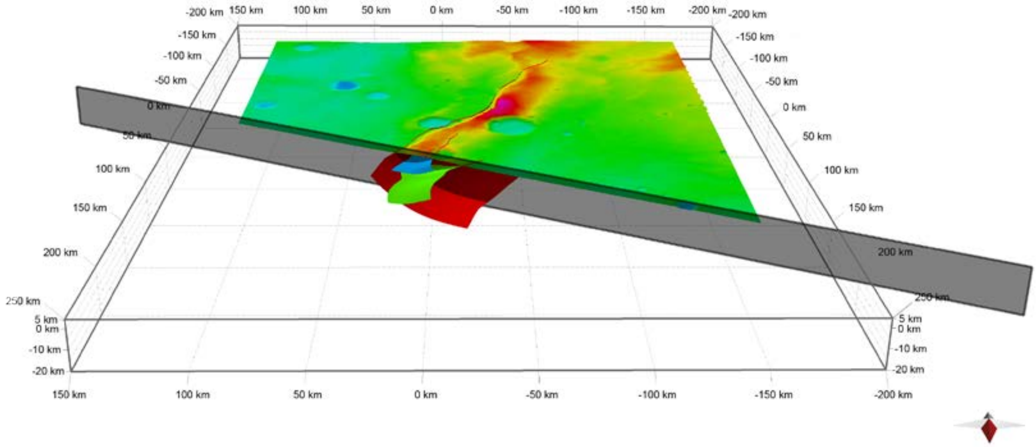

Figure 2. *3D diagram showing the resulting listric fault planes.*

it with the observed MOLA surface. The trishear method allows to model the anticline of the fault propagation fold along the structure, while the fault parameters control the width and height of the lobate scarp.

Ogygis Rupes thrust fault and the two backthrusts analyzed present a decrease of their dip angles with depth reflecting listric fault plane geometries that root at horizontal detachment levels (Fig. 2).

The depth of faulting obtained for Ogygis Rupes main fault is 17-18 km, which agrees with the depth of the BDT calculated by previous lobate scarp work for the Late Noachian-Early Hesperian [1, 2, 8, 9, 10, 3]. However, the two backthrusts included in the modeling present a much shallower depth of faulting suggesting the presence of mechanical discontinuities inside the Martian crust.

5. Acknowledgements

This research has been supported by the projects AMARTE II (PR75/18-21613), funded by the research program Santander-UCM, and TECTOMARS (PGC2018-095340-B-100), funded by the Spanish Ministry of Science, Innovation and Universities. A. Herrero-Gil work has been supported by a FPI2015 grant BES-2015-073983, funded by the Spanish Ministry of Economy and Competitiveness (MINECO). The software MOVE 2018.2 was provided by Petroleum Experts Ltd. thought the donation of an Academic license to the Departament of Geodynamics, Stratigraphy and Paleontology of the Universidad Complutense de Madrid.

6. References

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