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MAJOR VOLCANIC FORMATIONS ON THE SURFACE OF MARS IN THE ELYSIUM PLANITIA REGION.

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The Elysium Planitia region is the second largest volcanic region on Mars (Fig. 1). It is located significantly west of the largest Tharsis Province. Several volcanoes of quite large sizes have also been found there, although somewhat smaller than the giant formations in Tharsis Regio.

The presented map shows the main features of the relief around the largest mountain peak here, Elysium Mons, and marks the landing site of the “InSight” module (designated as NSY) [6], the “Viking Lander 2” (VL2) [20], the “Mars Science Laboratory” (MSL) “Curiosity” rover in Gale crater [10], and the “Mars Exploration Rover” (MER) “Spirit” in Gusev crater. Note that the “InSight” spacecraft landed almost on the surface at the boundary between the densely cratered highlands to the south and the lowlands of Utopia Planitia to the north.

Elysium Mons is the most massive volcano in the Elysium Planitia region; it is about 12.6 km high above its base and about 240 km in diameter. At its summit is a caldera with about 14 km in diameter. Elysium Mons is surrounded by smaller volcanoes: Albor Tholus to the southeast and Hecates Tholus to the northeast. Hecates Tholus is the northernmost of the volcanoes in the Elysium province; its diameter is 182 km. On the western slope of this volcano is a caldera 10 km in diameter, formed by an eruption about 350 million years ago. Albor Tholus is 4.5 km high and 160 km in diameter at its base. Albor Tholus has a caldera 30 km in diameter and 3 km deep; this is a significant depth compared to calderas on Earth. Analysis of the terrain of Elysium Planitia [4] shows that lava flows from Elysium Mons should have flowed mainly in a southerly direction. To the east of the InSight lander, very young lava flows over 150 km long can be seen flowing from Cerberus Fossae down the Athabasca Valles. The InSight lander’s research was focused on studying the interior of Mars. Therefore, the choice of this landing site was oriented towards the fairly flat surface of Elysium Planitia. The center of the InSight landing site has coordinates 4.5ºN, 135.9ºE; this is almost 600 km from the Curiosity rover’s location in Galle crater. Therefore, immediately after the launch of the mission in May 2018, throughout the entire flight to Mars, it was the European Space Agency (ESA) that supported the InSight mission with its network of ground stations.

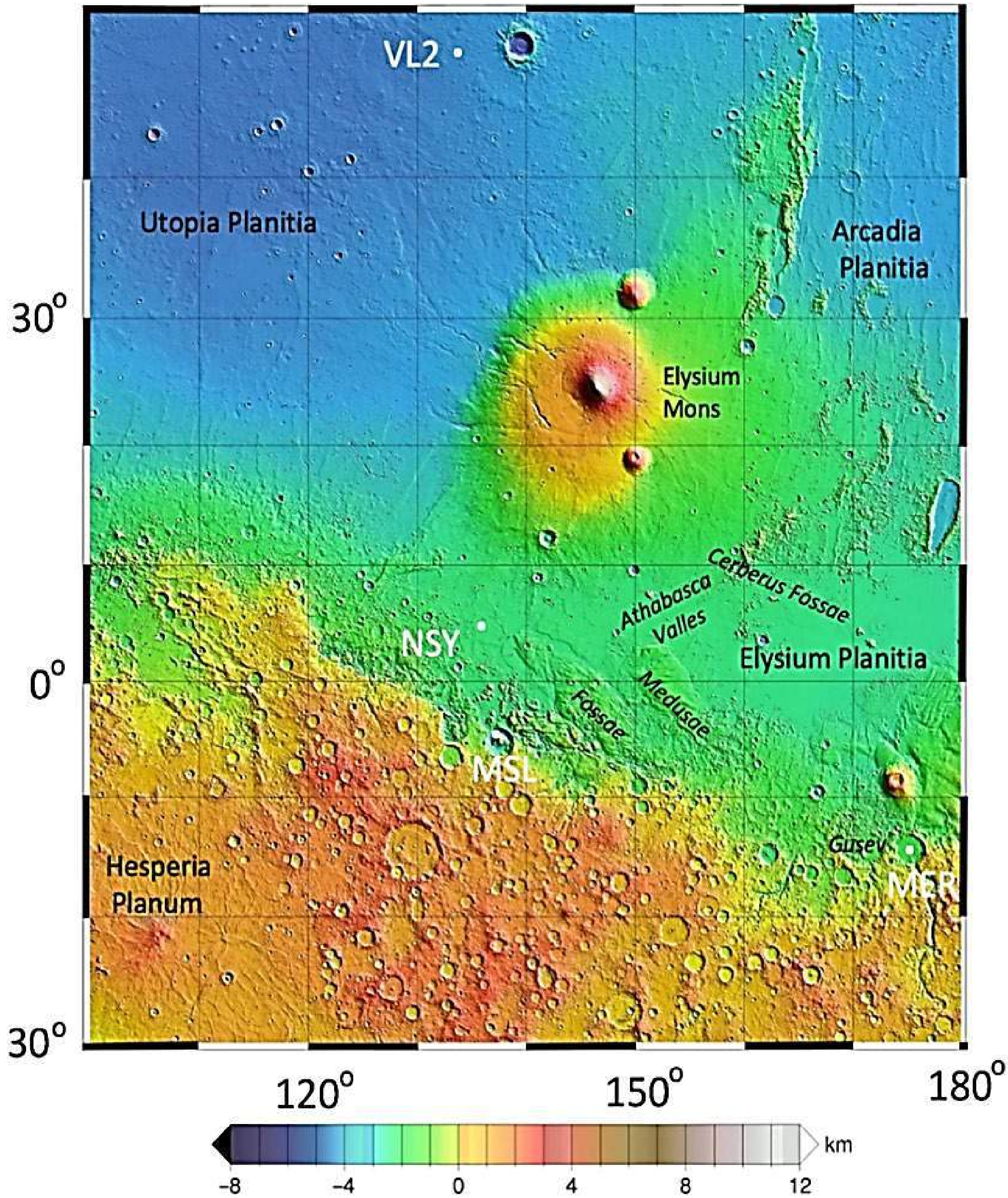

Figure 1. The Elysium Planitia Volcanic Region is the second largest on Mars after Tharsis Regio (https://media.springernature.com/full/springer-static/image/art%3A10.1038%2Fs41467-020-14679-1/MediaObjects/41467_2020_14679_Fig1_HTML.png?as=webp).

The Elysium Planitia region is characterized by a rather complex geological history. It has a rather diverse and multifaceted relief structure [29, 32] and geological formations, which are an example of the rich geological history of Mars. After all, in this region there are many volcanic plains bordering extensive, winding lava flows and materials that are predominantly basaltic in origin.

All of them indicate active past volcanic activity [16, 24, 25, 27, 35], which left noticeable traces. Witnesses of this tectonic history are a large number of faults and cracks that cross the now fairly flat surface. These formations are evidence of the interaction between stresses in the Martian crust and volcanic formations that shaped the existing landscape of the planet's surface over many millennia [2, 3]. The geological history of the formation of the Elysium Planitia plain complex was also influenced by aeolian and fluvial processes. Ancient riverbeds and so-called dust devils [8, 9, 12, 34, 36] have made an additional contribution to the geological and ecological history of Mars. The study of these features allows us to reveal historical climate changes [33] and to understand past geological processes more deeply.

Radar studies conducted by scientific instruments using advanced technological tools on several spacecraft have revealed large volumes of water ice deposits [15, 22, 26] under the Martian crust, located under the surface of the planet in the Elysium Planitia region. Such a discovery has allowed us to improve our understanding of the rather complex hydrological cycles on Mars, and to reveal the features of the presence of ancient water resources and their potential participation in the formation of various life forms [18, 19, 21, 23].

The presence of numerous impact craters of various sizes and the study of the morphology of surface formations on the Elysium Planitia plain have allowed us to delve deeper into the chronology of evolution, geological changes, and climatic changes [14] that have occurred on the surface of Mars over many millions of years.

This plain, Elysium Planitia, has been studied by several scientific missions, each of which has tried to decipher the ecological and geological mysteries characteristic of this Martian plain. For example, the main goal of the NASA mission “InSight” was to study seismic activity [3, 6, 11] and measure heat flows [31] from the Martian interior to better understand the dynamics of tectonic activity, internal structure, and geological processes that have previously shaped and continue to shape the interior of Mars [17].

The results obtained by the mission “InSight” have become one of the decisive ones in building a comprehensive model of the geology of Mars.

The Mars Reconnaissance Orbiter spacecraft has been used to map and study the geological features of Elysium Planitia in detail. Several instruments and devices have been developed for this mission to expand our knowledge of the geological composition and history of changes in the region.

The European Space Agency’s Mars Express mission has deepened our understanding of the subsurface structure of Elysium Planitia and the morphological characteristics on the visible surface. The information obtained with the Mars Express spacecraft has improved our understanding of the vertical structure beneath the Martian surface, and has explored the interaction of the planet’s atmosphere [1, 5, 13, 30] with surface processes, etc.

Each of the geomorphological features of Elysium Planitia speaks of a specific type of geological history of the region. For example, extensive volcanic plains [27] dominate the entire landscape of the plain. They are evidence of ancient volcanic activity that once shaped this region. Therefore, this plain is a kind of repository that preserves the features of past processes, the history of a significant number of eruptions that have always shaped this region on the surface of Mars.

And the study of this plain is crucial in reconstructing historical changes on the planet, allowing us to reflect the evolution and climatic changes on Mars [14, 28].

The presence of cracks and fissures on the surface of Elysium Planitia indicate intense tectonic dynamics in this region, preserving the history of crustal deformation, possible tectonic plate displacements under the surface of the planet and relief formations caused by stresses in the crust. And space missions to the Elysium Planitia plain have significantly expanded our understanding of the internal structure of Mars, geological processes and environmental conditions.

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COMPARATIVE STUDY OF LAMB WAVE INTERACTION MECHANISMS WITH STRUCTURAL DAMAGES IN FIBER-REINFORCED LAMINATES

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Abstract. This study presents a detailed investigation of Lamb guided wave interaction with delamination in laminated composite structures. Using the time domain spectral finite element method, the research characterizes wave scattering as a function of delamination depth and location. Local wave field properties are analyzed across various layer-wise positions to identify specific signal signatures. Results demonstrate that off-axis delamination induces an asymmetry in elastodynamic stress transfer, leading to significant wave mode conversions. The sensitivity of these waves to different signal wavelengths is evaluated, revealing that frequency-wavelength data can effectively distinguish between various sizes of internal defects. Furthermore, the numerical model facilitates an extensive analysis of scattering effects caused by