VOLCANO-TECTONIC EVOLUTION OF THARSIS THOLUS, MARS.

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We present preliminary results from an on-going project aiming to study physical processes of Martian volcanism. In order to obtain the best possible identification and characterization of the volcanic products and landforms, image processing and numerical stereo-photogrammetry [1] techniques are applied to the Viking imagery *(fig. 1)*. Our preliminary work is a study of Tharsis Tholus (13N° 91°) a 120 by 150 km wide volcano which is an old (3.5 -3.8 Ga [2]) dome, partially embayed by surrounding lava plains [3]. Its volcano-tectonic history was briefly described in [4] but have not yet been thoroughly documented.

Methods.

- Image processing techniques are used to carry out a detailed photo-interpretation of medium and high resolution images.
- Software, developed at the University College of London [1] to extract topographic information from Viking Orbiter imagery, are used to obtain more detailed DTMs than the ones published by the USGS [5]. The UCL software are based on automated stereo-matching techniques and have proven to be well-suited for the study of structures such as volcanoes [6]. The DTM obtained for Tharsis Tholus allows one to carry out 3D analyses of the structures and morphologies.
- In the near future, in order to improve the identification and the characterization of the surface of the Martian volcanic products, we intend to apply new methods of textural analysis which are currently developed in our laboratory.

Results.

Tharsis Tholus appears to result from the coalescence of two volcanoes with the main one occupying the northern two thirds of the edifice. A relatively complex history may be derived for the whole system. It includes major volcano-tectonic events such as wide flank collapses and caldera subsidences.

The main volcano.

Its eastern and western flanks are respectively affected by two major sector collapses. Their heads have been subsequently modified by the formation of a central caldera. The eastern collapse is about 90 km wide at the base of the edifice and about 50 km wide near the summit; the height of its northern and southern rims range from 0 to 2 km. For the western collapse, these values are respectively 80 km, 45 km, and 0 to 1 km.

A 35 km wide and 2.5 km deep caldera has formed at the summit. It is bounded by a set of concentric faults which limit blocks forming steps in the caldera rim in the S-SE half of the depression. These steps seem to be analogs of those observed on some terrestrial calderas (e.g. Kilauea). The northwestern rim has been deeply eroded. It exhibits a spur and gully morphology never described in the summit area of volcanoes of this type on Mars, but sometime observed on exceptionally high canyon walls of Valles Marineris [7]. We note that this part of the caldera rim of Tharsis Tholus is also exceptionally high (up to 5 km), because it merges with a landslide rim.

The southern secondary edifice.

An almost completely concealed caldera is identified in the topography of the southern flank of Tharsis Tholus. Only the northwestern part of the rim remains visible whereas the rest of the caldera may be delineated by the presence of a nearly flat circular area, dipping 1° southward and about 45 km in diameter, that marks the infilling of the caldera by subsequent activity. This eccentric caldera attests the presence of an independent volcano on the southern flank of the main edifice.

Tectonics and chronology.

A regional syn, or post, Amazonian [8] N55 extension tectonic phase affects most of the structures and surfaces of the volcano. This tectonic episode and the observable relations between the volcano-tectonic structures and the surface lithologies provide constraints to define a relative chronology of the events in the evolution of Tharsis Tholus

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The map on figure 2 summarizes the new interpretation of the evolution of Tharsis Tholus which will be presented in detail.

The surface of three areas, the central caldera, the southern caldera and the southern half of the eastern flank collapse are apparently devoid of N55 grabens and would, thus, have been resurfaced after the Amazonian extension phase. This implies a more recent volcanic activity than previously calculated from global crater counting [2].

However, it has to be stressed that the texture of the volcanic products at the surface are usually not very contrasted or characteristic of typical volcanic formations. It is difficult, therefore, to assess the exact nature of the volcanic products in surface for most areas and, as a result, little may be inferred about the type of the eruptions that took place on Tharsis Tholus.

Future work.

Three main problems remain unsolved: (i) the absolute ages of the different identified formations, (ii) the nature of these formations and (iii) the origin and mechanism of the two large-scale flank collapses. Further studies will be undertaken to address these issues. Respectively: (i) detailed crater counting for the different areas, (ii) textural analysis which will be compared to terrestrial analogs and (iii) simulation on scale models to test the hypothesis of flank collapses by a gravitational spreading of the edifice in presence of an underlying ductile layer.

References

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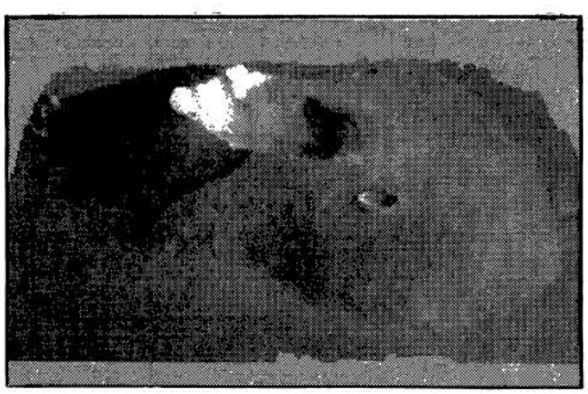

Figure 1 : 3D view of Tharsis Tholus from the south. Vertical exaggeration 10x.

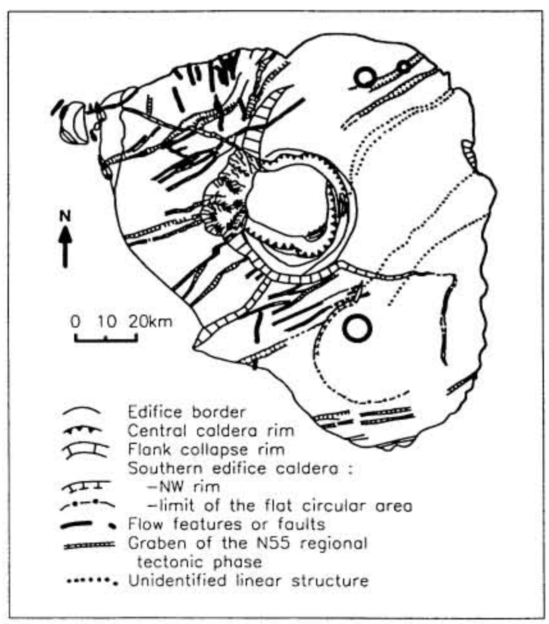

Figure 2 : Main volcanic structures of Tharsis Tholus.