SUB-LITHOSPHERIC 'SUBDUCTION' ON MARS: CONVECTIVE REMOVAL OF A LITHOSPHERIC ROOT. III: SYRIA PLANUM REGION. Evelyn D. Scott. Planetary Science Research Group, I. E. N. S., Lancaster University, Lancaster LA1 4YQ, U. K. E.Scott@Lancaster.ac.uk

Abstract: A thickened lithospheric root anchoring the region containing Syria Planum in buoyant equilibrium is detached by convective eddies within the asthenosphere, which then upwells, into the space left by the root, and induces minor, new volcanic activity, probably of an evolved composition [1]. The crustal block, no longer anchored, rebounds buoyantly until it reaches a topographic high point where boundary stresses can no longer hold it in equilibrium and it begins to subside. At the same time, it spreads horizontally generating an extensional stress regime within itself and a compressional one in the region buttressing it, producing wrinkle ridge folding. The detached lithospheric root subducts to the base of the mantle where it produces the chemical and thermal homogeneities which trigger new plume formation. This model can explain how the Martian mantle remains sufficiently mixed to be able to generate prolonged volcanism within the Tharsis Province, for extended periods of the planet's history.

Syria Planum, Noctis Labyrinthus and Valles Marineris: Sinai, Syria & Solis Plana are smooth plains with little topography, surrounded by the fractured terrain of Noctis Labyrinthus & Valles Marineris to the north, the graben of Claritas Fossae and Thaumasia Fossae to the west and south, and by the wrinkle ridges of Melas Dorsa to the east. It is proposed in this abstract that the region around Syria Planum built a substantial lithospheric root which anchored it in buoyant equilibrium. This root was subsequently detached by convective eddies within the asthenosphere, causing the region to rebound topographically [1]. The asthenosphere upwelled and induced further minor volcanism within the area. There is evidence that the Plana were re-surfaced by basaltic lavas to a depth of about 0.5 km [2]. These flows are younger than the graben system of Noctis Labyrinthus [3], consistent with the fact that the volcanism is induced by the initial upwelling of the asthenosphere, but the graben form at a later stage when the region begins to subside. It is interesting to note that the volcanics on the floor of Valles Marineris are geochemically depleted relative to other Martian volcanism [4]. This supports the hypothesis that they represent the reactivation of underplated material by the proximity of the relatively hot asthenosphere. This whole situation is analogous to the end-stage fissure-fed volcanism at Alba Patera and the annular graben surrounding this volcano [5]. The collapse events within Noctis Labyrinthus are much more massive than those seen on Syria Planum itself. This is again similar to the situation at Alba Patera where the graben at the periphery are much larger features than the postulated faults parasitised by magma to form fissure-fed flows.

There have been five discrete episodes of faulting in the Syria Planum area [6]. The initial two episodes are consistent with thermal uplift and it has been suggested that a mantle diapir is responsible [6]. However, of significance is the change of style of faulting which occurred in the Early Hesperian, and produced tangential and circumferential systems. This indicates a change from that consistent with uplift to that produced during flexural downwarp [6]. This change of tectonic regime is consistent with events which are expected to accompany the convective removal of a lithospheric root [1]. At a critical distance, there should also be a change from extensional tectonics to compressional ones as the uplifted region begins to subside and spread horizontally [1] and in fact there are wrinkle ridges immediately to the east of the Plana, at Melas Dorsa. The whole tectonic episode lasted between two and three billion years, with uplift lasting several hundred million years and subsequent subsidence between one and two billion years.

If the lithospheric roots of the Plana were detached in a convective event, this would set into progress the isostatic rebound and eventual gravitational instability that produced the extensional features and the wrinkle ridges. However, the situation became complicated by the growth of the large volcanic shields of the Tharsis Volcanic Province, which exerted a loading force onto an already weakened lithosphere. This extended the Valles Marineris system to its present day morphology. This hypothesis easily combines the various hypotheses that Valles Marineris formed either as a thermal response to events in the Martian mantle or as a tectonic response to the loading of Tharsis. If it is argued that there is an asthenospheric upwelling below the Plana, then the Wernicke 'Simple Shear' model can be invoked to explain the opening of Valles Marineris. In this model the upwelling is lateral to the site of the rifting, whereas McKenzie's 'Pure Shear' model would locate the site of rifting immediately above the mantle decompression. The fact that the fissure system of Noctis

Labyrinthus has not evolved to the same extent as that of Valles Marineris could be because it is not as close to the thermal influence of the upwelling or because it has formed simply as a response to the isostatic realignment and was not influenced to as great an extent by the growth of the Tharsis volcanic shields.

Summary: It is argued that Syria, Sinai and Solis Plana were generated by the volcanic activity associated with a mantle plume. They formed a large lithospheric root which was removed in a convective downwelling initiating a buoyant rebound of the region, followed by later subsidence when this uplift could no longer be sustained. The sequence of faulting within the region [6] is consistent with this scenario.

References: [1] Scott (2000a) *Sub-lithospheric subduction: I The Mechanism*, LPSC 31; [2] Lucchitta et al. (1992) *In: Mars, Univ. Arizona*; [3] Solomon and Head (1982) *J. G. R.* [4] Mustard and Sunshine (1996) LPSC XXV; [5] Scott (2000b) Sub-lithospheric subduction II Alba Patera, LPSC 31; [6] Tanaka and Davies 1988 *J. G. R.*