CENTERS OF TECTONISM IDENTIFIED FOR THE WESTERN AND EASTERN HEMISPHERE OF MARS.

R. C. Anderson[1], J. M. Dohm[2], M. Golombek[1], A. F. C. Haldemann[1], and E. Pounders[1]; [1]Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA 91109, [2]University of Arizona. robert.c.anderson@jpl.nasa.gov.

Introduction: Structural mapping is key to unraveling geologic histories at local to global scales on Earth and Mars [e.g. 1]. For example, maps delineating structures of various ages can be used to characterize potential stress sources [e.g., *1*], strain magnitudes and history [e.g., *2*], and pre-existing structural controls that may relate to episodes of local or regional tectonism [3]. We have compiled a comprehensive global paleotectonic map of Mars, first presented in [4], to determine local and regional centers of tectonic activity by tracing the geographic distribution of fault and ridge systems as they formed during successive stages of major geologic activity [2,3] and by performing analysis of their spatial distribution and whether they are radial or concentric about a center through the Vector Analysis (VA) method of [1]. The centers of tectonic activity identified for both the western and eastern hemispheres of Mars from this analysis are shown in Table 1 [see 1 for a complete description of the methodology] and some of the more prominent in the geologic evolution of Mars described below. In general, there is a distinction between the two hemispheres—whereas multiple extensional and compressional centers within Tharsis dominates the western hemisphere, , the eastern hemisphere is marked by multiple dispersed compressional centers of activity in Hadriaca/Tyrrhena-, and Isidis/Syrtis- and possibly Arabia Terra-, and and extensional center at Elysium.

Centers of tectonism:

Syria Planum, western hemisphere (Noachian-Hesperian): The most dominant center of tectonism of Tharsis in the western hemisphere is Syria Planum [1,3,5]. It displays a complex system of radial faults of varying ages and occurs along the north-trending alignment of prominent features, including Claritas and Ceraunius rises [1,5] and Ceraunius Fossae [6]. Syria Planum displays a uniform distribution of simple graben segment densities through time [5], possibly suggesting that Syria Planum was the site of long-lived (Noachian to Late Hesperian/Early Amazonian), activity with a distinct episode of intensive tectonic activity during the Late Noachian/Early Hesperian that declined and transitioned into a volcanic setting [2,5].

Hadriaca-Tyrrhena Center (Noachian-Hesperian): The Hadriaca-Tyrrhena center located within the Hadriaca/Tyrrhena volcanic province is the most prominent center of compressional tectonism identified for the eastern equatorial region of Mars (Table 1). A statistically insignificant total amount of extensional features appear to be associated with the formation of this center. The growth of Hadriaca and Tyrrhena Paterae occurred along the margin of a large impact structure, Hellas, which may have also influenced the formation of the volcanic province (including the formation of Hesperia Planum; e.g., see [5]. Two major stages for the development of Hadriaca and Tyrrhena Paterae have been identified, which include distinct pyroclastic and effusive eruptive styles appearing in the Late Noachian and Late Hesperian, respectively, as well as magma-water interactions and associated outflow channel development (e.g., see [6]). A Late Noachian to Late Hesperian age for Hadriaca-Tyrrhena volcanic province is consistent with the age determination of this center. In addition, Hesperia Planum lavas affected by ridge systems (e.g. 5,6) appear more complex (e.g. trends) than other occurrences of wrinkle-ridged, plains-forming materials such as in the Sinai and Thaumasia Planae regions of the southeastern part of Tharsis (e.g. [2,3]), or in Lunae Planum in the eastern part of Tharsis [e.g.,7].

Isidis-Syrtis Center: The second largest center of compressional deformation identified within the eastern hemisphere is Isidis-Syrtis (Table 1). Similar to the Hadriaca-Tyrrhena center, extensional features associated with the formation of this volcanic province are statistically insignificant. This region contains the Syrtis volcanic province, which occurs on the margin of the Isidis impact basin. Isidis is a highly degraded impact structure that forms part of the highland-lowland boundary and occurs on the margin of the Utopia impact structure. Isidis has concentric graben still preserved in Noachian crust [9]. The major volcanic structure for this region is Syrtis Major, a broad, low shield volcano located on the southwest margin of the impact structure. Wrinkle ridges display a concentric pattern [10]. The concentric pattern suggests that local basin related stresses are responsible.

Arabia Terra Center (Noachian): Arabia Terra is a region of deformation identified in the eastern hemisphere. As with the Hadriaca-Tyrrhena and Isidis-Syrtis centers described below, extensional features associated with the formation of Arabia Terra are statistically insignificant (Table1). Although topographically broader and less defined as the other two centers, this center appears to be part of an ancient region (Late Noachian?) of Mars that displays a significant population of wrinkle ridges. This region is composed of predominately Noachian-aged materials, at the highland-lowland boundary region that is distinct from other boundary regions, includes the largest region of fretted terrain on Mars, numerous outflow channels such as Mamers Valles that do not have obvious origins, and distinct albedo, thermal inertia, gravity, magnetic, and elemental signatures from other boundary regions.

Ongoing investigation: Our investigation of the paleotectonic history of Mars includes investigating the centers of tectonism that may otherwise be subdued by the more prominent centers. For instance, we can readily extract dominant centers from the total digital dataset and rerun the Vector Analysis (VA) method of [1]. For example, by removing Tharsis from the dataset, we can identify otherwise subdued centers. We can also investigate whether impacts figure prominently in the paleoteconic record by defining/simulating a center of teconism (of any spatial extent) central to the impact basin (e.g., Hellas) and running the data to highlight the extensional and compressional features that point back to the center. Such strategies and associated results will be discussed at the meeting.

Center	Location lat/long	Radius of center	# of Ext. features identified	# of Comp. features identified	Kamb 3-sigma statistics Extensional	Kamb 3-sigma statistics Compressional
Claritas	27S, 106W	7	5444	1009	2394	1788
Valles	16S, 77W	10	3187	1702	4687	3499
SyriaNW	4S, 107W	5	4778	996	1245	930
Alba	37N, 107E	5	3473	367	1245	930
Elysium	20N, 150E	8	477	1653	3090	2307
TempeSW	33N, 81W	2	1546	252	203	151
Uranius	24N, 90W	1	822	135	51	38
Warrego	35S, 96W	3	1916	321	454	339
Ulysses	10N, 124W	2	1007	502	203	151
Pavonis	6N, 114W	3	2163	671	45	339
SyriaS	19S, 104N	5	4562	794	1245	930
Ascraeus	14N, 109W	2	1767	369	203	151
Olympus	25N, 135W	3	754	429	454	339
Ceraunus	22N, 109W	2	1838	296	203	151
Ht	25S, 115E	5	97	2436	1245	930
Isidis	10N, 80E	5	160	2271	1245	930
Arabia	35N, 55E	5	227	1925	1245	930

Table 1 Centers of Tectonic Activity identified for the Eastern and Western Hemisphere of Mars. *Radius based on 90-degree radius circle (note different from [1] where the radius was based on180-degree western region). **Bold** represent centers that pass the 3-Sigma Kamb statistics.

References: [1] Anderson, R.C. et al. (2001) *JGR.*,106, 20,563-20,585. [2] Dohm, J.M. et al. (2001a) *USGS Misc. Inv. Ser. Map I-2650*, scale 1:5,000,000. [3] Dohm, J.M. et al. (2001b) *JGR*. 106, 32,943-32,958. [4] Anderson, R.C. et al. (2006) *LPSC*, (abstract) (CD-ROM). [5] Ivanov, M.A. et al. (2005) *JGR*, 110, doi: 10.1029/2005JE002420. [6] Crown, D.A. et al. (1992) *Icarus*, 100, 1-25. [7] Scott, D.H. and Tanaka, K.L. (1986) *U.S. Geol. Surv. Misc. Invest. Ser. Map, I-1802-A*. [8] Dohm, J.M. et al. (2004) *LPSC, XXXV*, #1209 (abstract) (CD-ROM). [9] Comer, R.P. et al. (1985) *Rev. Geophys.*, 23: 61–92. [10] Hiesinger, H. and Head, J. (2004) *JGR*, 109, doi: 10.1029/ 2003JE002143.