SHALLOW CRUSTAL DISCONTINUITIES AND GRABEN AND SCARP FORMATION IN THE THARSIS REGION OF MARS; P.A. Davis and K.L. Tanaka, U.S. Geological Survey, Flagstaff, AZ 86001 and M.P. Golombek, Jet Propulsion Laboratory, Pasadena, CA 91109.

We recently obtained photoclinometric profiles across all simple grabens and erosional landforms (e.g., troughs, pits, wall-valley heads, and scarps that are bounded above and below by flat surfaces) that occur within Tempe Terra. These data, together with similar data that we obtained for Syria, Sinai, and Lunae Plana [1,2] and the Alba Patera region [3], allow regional examination of shallow crustal discontinuities between latitude 30° S. and 50° N. and longitude 50° W. and 112° W. The profile for each simple graben was used with an appropriate structural model [2,4] to estimate the depth to the base of the faulted layer. The depths of erosional wall scarps may also indicate the depths of mechanical discontinuities such as a local lithologic or cryospheric boundary. Examination of these data indicates a surprisingly consistent set of shallow crustal discontinuities for the Tharsis region at depths of 0.4-0.6 km, 1.0-1.4 km, and 2 km; the maximum depth of the features in most study areas appears to be about 4 km (Fig. 1).

The concentration of values between 0.4 and 0.6 km in most scarp and some faulted-layer depth data is similar to the range in estimated thicknesses of individual exposed Noachian and Hesperian plains units [5-7] in the Tharsis region. The regional depth data also show two modes near 1 and 2 km in some study areas and a maximum depth near 4 km in most study areas (Fig. 1); the faulted-layer depths in excess of 4 km at Alba Patera occur near the summit of the caldera and could be attributed to volcanic loading. Our detailed examination of these depth data includes the following observations: (1) The mode at 1.0-1.4 km depth transcends age and geologic setting in this broad study area. (2) The 2-km mode is most obvious at Alba Patera and moderately well developed at Syria and Sinai Plana, but it is muted at Tempe Terra, which is in the same latitude range as Alba Patera but older. (3) The 2-km-depth mode is not present in all areas that have features of Amazonian age [2].

We suggest two possible explanations for our observations in the Tharsis region [see 8]: (1) The cryosphere thickens from 1 km to 2 km toward higher latitudes, as suggested by thermal-diffusion models [9-11], but it did not fully develop to a thickness of 2 km at latitudes above 30° until Amazonian time [11]. (2) In these volcanic terrains on Mars, the 1.0- to 1.4-km depth represents a possible physical limit to non-eruptive dike ascent, which may be controlled by the depth of onset of magma vesiculation[12-13]; the 2-km depth represents the interface between the Martian megaregolith above and more solid basement below [9,14,15], which locally may reach a depth of 4 km. Dike intrusion and, in places, eruption in these volcanic terrains are supported by photogeologic observations of lava flows that originated from grabens [1,16-18]. A combination of the cryogenic and volcanic scenarios is probably most likely.

References: [1] Tanaka and Davis (1988) *J. Geophys. Res., 93,* 14,893; [2] Davis and Golombek (1990) *J. Geophys. Res., 95,* 14,231; [3] Davis *et al.* (1991) *Lunar Planet. Sci. XXII,* 285-286; [4] Golombek (1979) *J. Geophys. Res., 84,* 4657; [5] Plescia and Saunders (1980) *Proc. 11th Lunar Planet. Sci. Conf.*, 2423; [6] De Hon (1985) *Lunar Planet. Sci. XVI,* 171; [7] Frey and Grant (1990) *J. Geophys. Res., 95,* 14,249; [8] Tanaka *et al.* (1991) *J. Geophys. Res., 96,* 15,617; [9] Fanale (1976) *Icarus, 28,* 179; [10] Rossbacher and Judson (1981) *Icarus, 45,* 39; [11] Fanale *et al..* (1986) *Icarus, 67,* 1; [12] Parfitt (1991) *J. Geophys. Res., 96,* 10,101; [13] Head and Wilson (1981) *J. Geophys. Res., 86* , 2971; [14] Woronow (1988) *LPI Tech. Rep. 88-05,* 135; [15] MacKinnon and Tanaka (1989) *J. Geophys. Res., 94,* 17,359; [16] Moore and Hodges (1980) *NASA TM 82385,* 266; [17] Plescia (1981) *Icarus, 45,* 586; [18] Schneeberger and Pieri (1991) *J. Geophys. Res., 96,* 1907.

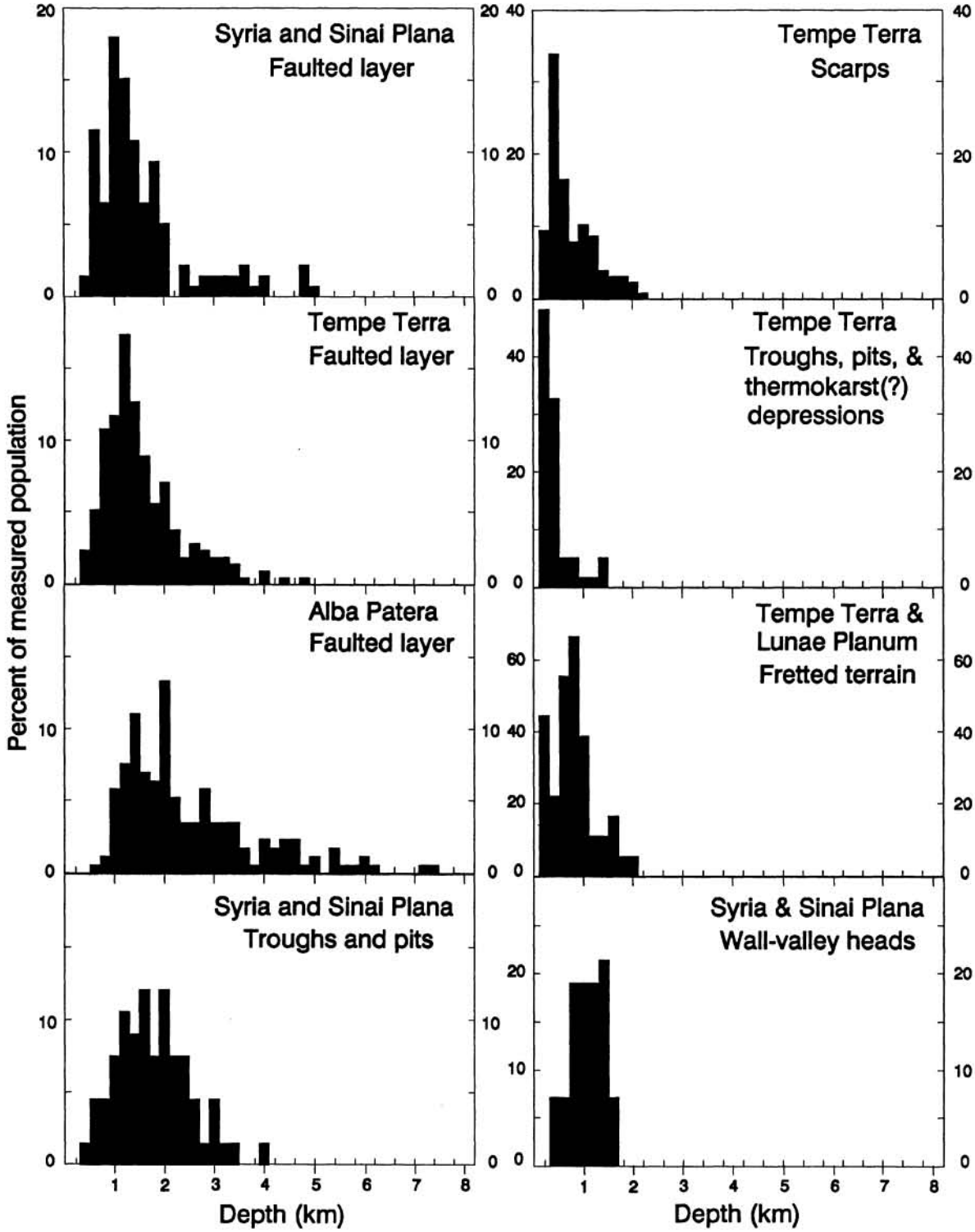

Figure 1. Calculated depths to the faulted layer and measured depths of various types of erosional scarps in several study areas in the Tharsis region of Mars.