TIMING OF ANCIENT EXTENSIONAL TECTONIC FEATURES ON MARS R. Wichman and P.H. Schultz, Dept. of Geological Sciences, Brown University, Providence, RI 02912.

Introduction: Although numerous studies have delineated the Tharsis and post-Tharsis volcanic/tectonic history on Mars (e.g., 1,2,3), only a few attempts (2,4,5) have examined the earlier epochs. This is not an easy task since unambiguous crater ages for pre-Tharsis and early Tharsis units are difficult to determine owing to a variety of active surface processes. Ancient tectonic features, however, have a sufficiently large superposed crater population that should permit relative dating. Tanaka (6) proposed a technique for crater counting along linear features analagous to areal crater density. A modification of this approach has been tested and applied to a variety of ancient tectonic features.

Approach: Tanaka (6) previously reported a method for determining the areal density for narrow elongate or linear areas. This method creates an envelope around the feature for any overlapping crater of radius R. The derived areal density depends on the mean diameter in any given size bin, which is controlled by the bounding diameter and crater production function. Our modification uses a discrete unbinned count where an observed arithmetic mean is calculated without an assumption about crater production. This expression has been successfully tested for arbitrary lines drawn through martian plains units with different crater ages.

Discussion: Figure 1 shows two global projections centered on Tharsis and Hellas. Our primary interest focuses on early and pre-Tharsis tectonic features where crater statistics are more reliable. Four broad tectonic systems are considered: Hellas, Isidis, Argyre, and Tharsis. Within the Hellas system, the older tectonic activity (or at least the earliest cessation of activity) is associated with a concentric system of broad troughs (H2,H3) 1900 km to the west and northwest of the center of Hellas. This system predates most easily identified volcanic constructs in this hemisphere. A significantly younger concentric system occurs farther west from Hellas (2400 km) at about the same distance and time as Tyrrhena Patera. Hesperia Planum was emplaced in the same concentric zone at a significantly later time. The Isidis system is first marked by the development of the Isidis scarp. It is likely that scarp actually dates from the time of basin formation but erosional processes result in a slightly younger crater age. Amenthes Rupes (AR) is part of a system of Isidis-radial scarps and plains-filled troughs dating from the earliest period. The Isidis concentric grabens were formed later: at about the same time as Tyrrhena Patera, all of which appear to be part of a Hellas-radial pattern (5). In the opposite hemisphere, ancient graben systems date from about the same time as the oldest Hellas concentric troughs and the Isidis-radial trough. These features are loosely grouped as part of the Tharsis system but occur more than 90^{o} from Tharsis. Grabens crossing the Elysium knobby terrains apparently began prior to the development of this knobby relief and the fretted margins east of Isidis--a date consistent with the preservation of some of these structures. Mareotis Fossae and the distant troughs north of Argyre are contemporary with the development of the knobby terrains. The generally recognized ancient Tharsis-radial grabens of Alba, Tempe, and Tantalus are younger structures contemporary with the older volcanic patera and Bosporos Rupes, which is part of the Argyre system. Later Tharsis grabens appear to be contemporary with the development of the oldest ridged plains and volcanic shields.

Finer time resolutions are not yet possible. Nevertheless, four groupings of the data on a global scale may be emerging. The earliest epoch is related to the Hellas and Isidis basins with an ancient parallel system in the Elysium region (log N > 700 where N5=cumulative number of craters larger than 5 km per 10^6 km^2). A second epoch is expressed by basin radial/concentric systems, patera construction in the Hellas hemisphere, earliest Tharsis radial/concentric patterns in the opposite hemisphere, and the development of fretted/knobby terrains of Elysium (log N5 = 350 to 700). This epoch was followed by more extensive radial/subradial grabens in the Tharsis hemisphere and the emplacement of the older ridged volcanic plains (log N5 = 175 to 350). Extensive volcanic shield development and later plains occurred in the next epoch (log N5 = 100-175. Future studies will examine whether or not these are gradational epochs and will attempt to refine/test these preliminary results.

References: (1) Plescia, J.B. and Saunders, R.S. (1982) J. Geophys. Res., 87, p. 9775-9791; (2) Wise, D.U., Golombek, M.P., McGill, G.E. (1979) Icarus, 38, p. 456-472; (3) Carr, M.H. (1981) The Surface of Mars (Yale Univ. Press, New Haven 1981), p. 202; (4) Wise, D.W., Golombek, M.P., McGill, G.E. (1979) J. Geophys. Res, 84, p. 7934-7939; (5) Schultz, P.H. (1984) Lunar and Planet. Sci. XV, p. 728-729; (6) Tanaka, K.L. (1982) NASA TM 85127, p. 123-124.

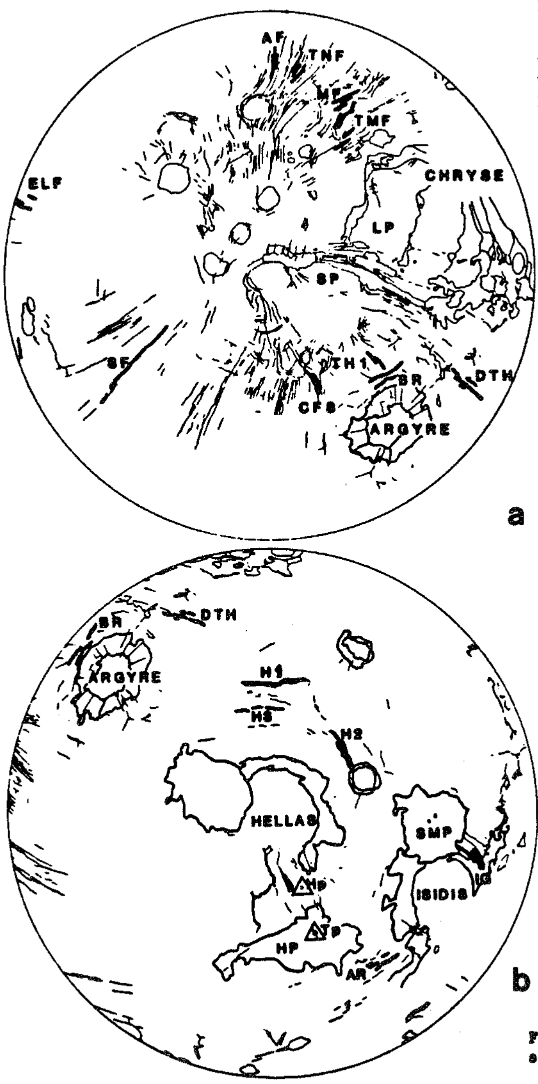

FIGURE 1. Tharsis-centered Lambert projection (Fig. 1a) of tectonic and selected geologic features showing dated fractures systems. ELF=Elysium fractures, AF=Alba Fossae, TNF=Tantalus Fossae, MF=Mareotis Fossae, TMF=Tempe Fossae, DTH=Distant Tharsis Fracture, BR=Bosporos Rupes, TH1=Recent Tharsis fracture, CFS=Claritas Fossae South, SF=Sirenum Fossae, LP=Lunae Planum, SP=Sinai Planum.

Hellas-centered Lambert projection (Fig. 1b) of tectonic and selected geologic features showing dated fracture systems. BR=Bosporos Rupes, DTH=Distant Tharsis Fractures; H1, H2, H3=Hellas concentric systems 1,2,3; AR=Amenthes Rupes, IG=Isidis concentric system. SMP=Syrtis Major Planitia, HP=Hesperia Planum, Tp=Tyrrehena Patera, Hp=Hadriaca Patera.

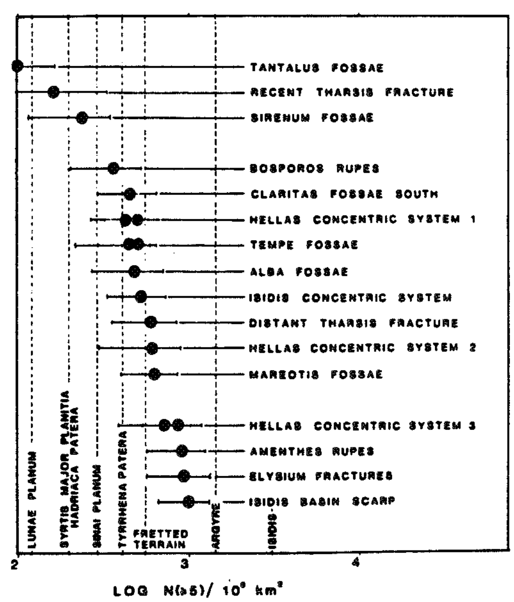

Figure 2. Age plot of dated fracture systems in areal crater density with seven volcanic and impact reference dates.