N90-12446

IMPACT CRATERING AND THE SURFACE AGE OF VENUS: THE PRE-MAGELLAN CONTROVERSY; G.G. Schaber, Shoemaker, E.M., Shoemaker, C.S., and Kozak, R.C.; U.S. Geological Survey; Flagstaff, Arizona 86001

The average surface age of a planet is a major indicator of the level of its geologic activity and thus of the dynamics of its interior. Radar images obtained by Venera 15/16 from the northern quarter of the Venus (lat 30° to 90°) reveal about 150 features that resemble impact craters, and they were so interpreted by Soviet investigators B.A. Ivanov, A.T. Basilevsky, and their colleagues [1, 2]. These features range in diameter from about 10 to 145 km. Their areal density is remarkably similar to the density of impact structures found on the American and European continental shields [3].

The Soviet investigators interpreted the record of apparent impact craters as indicating a mean age for the observed surface of Venus of about 1 b.y. (±0.5 b.y.)[1,2,4]. Schaber et al. [5], however, pointed out that the observed Venusian craters may imply an average crater-retention age for the region surveyed no greater than the 450-million-year mean age of the Earth's crust, a result consistent with the expected thermal and tectonic history of Venus (whose size and mass, and probable composition are similar to Earth's).

The basic difference between the Soviet and American estimates of the average surface age of Venus's northern quarter is due to which crater-production rate is used for the Venusian environment. Cratering rates based on the lunar and terrestrial cratering records, as well as statistical calculations based on observed and predicted Venus-crossing asteroids and comets, have been used in both the Soviet and American calculations. The single largest uncertainty in estimating the actual cratering rates near Venus involves the shielding effect of the atmosphere. Melosh [6] has determined that breakup of stony asteroids during penetration of Venus' atmosphere would inhibit formation of craters much smaller than 20 km in diameter. In fact, the Venera 15/16 data indicate that relatively few of the apparent impact craters on Venus are smaller than 20 km.

Shoemaker and Shoemaker [3] suggested that the size distribution of Venusian impact craters with diameters >20 km is similar to the size distribution of young craters on the Moon. Because most young craters larger than 60 km in diameter on the Earth and Moon are probably due to cometary impact, most of the largest impact craters on Venus were also probably produced by cometary impact [3]. Applying their best estimate of the proportion of craters produced by asteroid impact, and using the cratering rate down to 20-km diameter found for the last 120 million years on Earth [7], Shoemaker and Shoemaker [3] found the mean age indicated for the surface surveyed by Venera 15/16 to be 210 ± 105 million years, consistent with Venus' surface age reported earlier by Schaber et al. [5]. For the largest craters (50-100 km in diameter), assuming the expected crater production by cometary impact, Shoemaker and Shoemaker [3] found an average surface age of about 400 million years, which they recently concluded [3] is the most probable average age. Should some fraction of the impact craters identified by the Soviet scientists ultimately prove to be of volcanic origin [8], the average surface age could of course be younger. Statistical evidence for a non-random distribution of the suspected impact craters on Venus [9-11] strongly suggests the presence of terrains of different ages that may include regions of active volcanism and tectonism.

REFERENCES CITED: [1] Ivanov, B.A., Basilevsky, A.T., Kryuchkov, V.P., and Chernaya, I.M., 1986, Proc. 16th Lunar and Planet. Sci. Conf., J. Geophysical Res., 91, D413-430; [2] Basilevsky, A.T.and seven other authors, 1987, J. Geophy. Res., 92, B12, 12,869-12,901; [3] Shoemaker, E.M. and Shoemaker, C.S., in The New Solar System (revised edition by J. Kelly Beatty; Sky Publishing Corp., Cambridge, Mass. and Cambridge Univ. Press, Cambridge, England; [4] Ivanov, B.A. and Basilevsky, 1987, Solar System Res., 21, 2, 84-89 (translation from Astronomicheskii Vestnik, 21, 2); [5] Schaber, G.G., Shoemaker, E.M., and Kozak, R.C., 1987, Solar System Res., 21, 2, 89-94; [6] Melosh, H. J., 1981, in Multi-ringed Basins; Proc. 12th Lunar Planet. Sci. Conf., part A, 29-36; [7] Grieve, R.A.F., 1984, Proc. 14th Lunar Planet. Sci. Conf., J. Geophy. Res., 89, B403-B408; [8] Kozak, R.C. and Schaber, G.G., Repts. of the Planet. Geol. and Geophys. Program-1986, NASA TM 89810, 443-445; [9] Burba, G.A., 1989, Lunar Planet. Sci. XX, Abs. submitted to XX Lunar Planet. Sci. Conf., 123-124; [10] Plaut, J.J. and Arvidson, R.E., 1988, J. Geophys. Res., 93, B12, 15,339-15,340; [11] Plaut, J.J. and Arvidson, 1988, Repts. of the Planet. Geol. and Geophys. Program-1987, NASA TM4041, 410-412; [12] Wood, C.A. and Coombes, C.R., 1989, this volume.