VOLATILE HISTORY OF MANGALA VALLES, MARS; *Robert A. Craddock*[1], *James R. Zimbelman*[1], *Ronald Greeley*[2], *and Ruslan O. Kuzmin*[3], [1]*Center for Earth and Planetary Studies, National Air and Space Museum, Smithsonian Institution, Washington, DC 20560,* [2]*Department of Geology, Arizona State University, Tempe, AZ 85287,* [3]*Vernadski Institute, U.S.S.R. Academy of Science, Moscow, USSR 117975*

Previously we have discussed observations describing several important components of the complex history of Mangala Valles that have been recognized through the results of 1:500,000-scale geologic mapping efforts [1]. These results describe the unique aspects of the Memnonia region of Mars and the role volcanism, tectonism, and the fortuitous location the Daedalia basin played in creating the Mangala Valles channel system. Structural elements in the region profoundly influenced the migration of volatiles and were the cause of subsurface volatile release.

Available Earth-based radar and topographic data [2,3] indicate that the Mangala Valles channel system is roughly contained within an area which is 3 km above Mars datum. These data combined with regional structural features suggest three possible source regions for the volatiles: (1) as a possible result of the Daedalia basin, highland materials west of 165° longitude are 3 km higher than the Mangala Valles area and are tilted eastward towards the channel [4]. (2) In a similar manner, highland materials south of Mangala Valles at -30° latitude rise 2 km above the surroundings and are somewhat parallel to the source graben [3]. Volatiles contained within either one or both of these regions may have saturated the regolith early in Martian history. Following a global cooling, volatiles in the regolith would have formed a permafrost layer which thickened with time. As suggested by Carr [5], unfrozen volatiles may have become confined under pressure, perhaps even exceeding lithostatic pressures in certain circumstances. The slope of these materials towards Mangala Valles would have aided in increasing the regional hydrostatic pressure. (3) Growth of the Tharsis rise, due east of Mangala Valles, during the early Hesperian and subsequent magmatic activity in the southern Tharsis region [e.g., the parasitic volcanic rise on the southern flanks of Arsia Mons; 2], may have been responsible for the generation of melt water by heating ground ice contained within early-stage lava flows and the underlying regolith. On Earth, areas with the highest permeabilities are found in volcanic terrain [6, pg. 151]. We propose that regional topography allowed volatiles to migrate and concentrate into a substantial volatile reservoir, and local volcanic/tectonic activity around the Mangala Valles source caused the volatiles to be released.

Although at least two episodes of flooding have been proposed for features in northern Mangala Valles [7], evidence for only one event consisting of multiple stages exists in the southern reaches. An early-stage, catastrophic sheet flood is evident in the terrain bordering the heavily incised channels. Locally pitted and scoured cratered terrain (e.g., Viking orbiter frame 451S15) may record this "proto-Mangala Valles". With time, discharge decreased and the release of volatiles became more confined. The flood magnitude can be quantized from measurements of channel dimensions [8]. Estimates of the discharge for the distal reaches of Mangala Valles range from 10^6 to 10^7 m/s [9], leading to an inferred duration for the flood event(s) spanning 6 to 60 days [7]. Calculations for the proximal portion of Mangala Valles (Fig. 1) provide discharge rates similar to those inferred for the distal reaches, but only with large flow velocities and flow depths (Table 1) through the breached graben source (line B in Fig. 1). The erosion which should accompany such values is difficult to reconcile with the narrow (5 km) width of the source. Lower discharge rates through this confined breach require much longer durations for the flood event, increasing the potential significance of ice daming, etc., with the water release. Volatile discharge may have been much less than previously thought [7]. This implies, perhaps, that the permeability of Martian materials is lower than previous estimates [5,7].

Figure 1. Mangala Valles. Lines A and B refer to profiles taken across portions of the channel in order to calculate potential discharge amounts and velocities.

Table 1.

Profile	Depth (m)	Discharge (m^3/sec)	Velocity (m/sec)	Slope
A	200	1.2E8	26	.001
A	100	3.8E7	16	.001
A	10	8.3E5	4	.001
B	545	1.2E8	50	.001
B	435	1.2E8	62	.002
B	380	1.2E8	69	.003
B	260	3.8E7	31	.001
B	210	3.8E7	38	.002
B	180	3.8E7	43	.003

REFERENCES: [1] Craddock, R.A., et al., Lunar Planet Sci., XXI, 240-241, 1990. [2] Downs, G.S., et al., J. Geophys. Res., 87, 9747-9754, 1982. [3] U.S. Geological Survey, Misc. Invest. Series Map I-2030, 1:15M of Mars, 1989. [4] Craddock, R.A., et al., J. Geophys. Res., 95, 10,729-10,741, 1990. [5] Carr, M.H., J. Geophys. Res., 84, 2995-3007, 1979. [6] Carr, M.H., The Surface of Mars, Yale University Press, New Haven, 1981, 232 p. [7] Tanaka, K.L, and M.G. Chapman, J. Geophys. Res., 95, 14,315-14,323, 1990. [8] Komar, P.D., Icarus, 34, 156-181, 1979. [9] Robinson, M.S., and K.L. Tanaka, Geology, 18, 902-905, 1990.