ORIGIN OF SOIL-LIKE DEPOSITS AT THE MARS PATHFINDER LANDING SITE, MARS. H. J. Moore[1], T. J. Parker[2], Joy Crisp[2], M. P. Golombek[2] , Donald Bickler[2], Howard Eisen[2], Jeffrey Gensler[3], Albert Haldemann[2], J.R. Matijevic[2], and Lisa Reid[2], , [1]U. S. Geological Survey, Astrogeology Team, Menlo Park, CA 94025, [2]Jet Propulsion Laboratory, Caltech, Pasadena, CA 91109, [3]University of Texas, Austin, TX, 78712

Mars Pathfinder appears to have landed on deposits of catastrophic floods from Ares and Tiu Valles[1]. This interpretation is consistent with landforms seen in images taken from orbit by Viking and features observed in images taken from the surface by the Imager for Mars Pathfinder (IMP) and the Rover (Sojourner). In orbiter images, the site is (1) on a plain to the north and downstream of the mouths Ares and Tiu Valles, (2) north and west of stream-lined islands aligned in northerly directions, and (3) transected by subtle swales, ridges, and lineations that extend in northeasterly directions from the confluence of the Valles [1]. From the surface, IMP images include hills on the horizon (Twin Peaks) that appear to be small streamlined islands, imbricated boulders that tilt in the inferred northeasterly flow direction, and pebbles, cobbles, and boulders [2] (i.e. rounded and/or abraded rocks). Sojourner images provide close-up views that include pebbles, cobbles, and boulders, and poorly-sorted fine-grained deposits that appear to include granules[3]. About 16% of the surface near the Sagan Memorial Station (Mars Pathfinder Lander) is covered by rocks >3 cm[1,2,3]. The size-frequency and -area distributions of the rocks are consistent with those of rocks on the depositional Ephrata fan of the Channeled Scablands in Washington[1]. Thus, the possibility that some of the flood deposits are soil-like should be considered. In our discussion below, we accept the silica compositions [4] in a relative sense and neglect the stated errors because there appears to be a systematic pattern in the silica contents. For example, "soil" samples A-4, A-5, and A-10 have silica contents of 48.0, 47.9, and 48.2% respectively, but those of "soil" samples A-15, A-2, and A-8 rise to 50.2, 51.0, and 51.6%, respectively [4].

There are at least two soil-like deposits at the Station: (1) drift and (2) cloddy. Materials of Mermaid "dune" may be a third type. An indurated soil-like deposit may also be present because Sojourner was unable to scratch the material [3], but it is unclear whether all of the indurated materials were formed in situ or introduced by flood waters or some other process. Images and interactions of Sojourner's wheels with drift deposits show that they are (1) uniformly fine-grained , compressible dusts with small cohesions and friction angles and (2) superposed on adjacent materials[3]. Wind has sculpted the drifts to form moats on the up sides of rock and windtails on the downwind sides[2]. Drifts may be dusts deposited from the atmosphere [2].

Cloddy deposits may have a fluvial origin because they do not have the characteristics of eolian deposits. They form widespread "pebbly" surfaces []. Larger "pebbles" appear to be gray

and most "pebbles" in Sojourner's tracks are not disaggregated. The first "soil" analysis (A-2, SiO_2 ~ 51%) may have included some or parts of "pebbles" because the silica content is about 3% larger than those of the three other "soils" (A-4,5, and 10, SiO_2 ~ 48%) [4]. Images and interactions of Sojourner's wheels with cloddy deposits show that they are poorly-sorted, incompressible mixtures of dusts, mm- to cm- size clods and/or rock grains with small cohesions, but large friction angles , but few cm-size clods or pebbles were excavated [3].

The Mermaid "dune" deposit also may be fluvial because it is poorly sorted with a small cohesion and large friction angle. The dark surfaces of Mermaid may result from an eolian lag deposit of sands and granules of rock too large for wind entrainment [2] which is consistent with the modestly larger silica content (50%) of the lag surface (A-15) compared with the three other "soils" above [4]. The rock called Squash may be part of fluvial deposits because it appears to be in the process of being exhumed from the finer fraction of soil-like deposits in Sojourner images. Other positive features, such as Ender and Mini-Matterhorn, may be more cohesive phases of fluvial deposits because they also appear to be soil-like.

Scooby Doo (A-8), which is "bright pink"[2], may be a "soil" or crust that formed in situ because it forms a smooth, planar horizontal surface, similar bright materials coat rocks [2], the rover wheels expose similar bright materials elsewhere, and it has a silica content that is only about 3.5% larger than the three other "soils" above [4]. However, Casper, a meter or so to the north of Scooby, has similar reflectance properties, but Casper has ridged surfaces and resembles a buried rock. Thus, Casper and Scooby Doo could be rocks or fragments of indurated soil-like material that weretransported during the Are-Tiu floods rather than a smooth, planar horizontal deposit that formed in situ.

References: [1] Golombek, M.P, Cook R.A., Economou, T., Folkner, W.M., Haldemann, A.F.C.,Kallemeyn, P.H., Knudsen, J.M., Manning, R.M., Moore, H.J., Parker, T.J., Rieder, R., Schofield, J.T., Smith, P.H., and Vaughan, R.M., 1997, Overview of the Mars Pathfinder Mission and assessment of Landing site predictions: Science, v. 278, #5344, 1743-1748. [2] Smith, P.H., Bell, J.F. III, Bridges, N.T., Britt, D.T., Gaddis, L., Greeley, R., Keller, H.U., Herkenhoff, K.E., Jaumann, R., Johnson, J.R., Kirk, R.L., Lemmon, M., Maki, J.N., Malin, M.C., Murchie, S.L., Oberst, J., Parker, T.J., Reid, R..J., Sablotny, R., Soderblom, L.A., Stoker, C., Sullivan, R., Thomas, N., Tomasko, M.G., Ward, W, and Wegryn, E., Results from the Mars Pathfinder camera: 1997, Science, v. 278, #5344, 1758-1765. [3] Rover Team, 1997, Characterization of the Martian surface deposits by the Mars Pathfinder Rover, Sojourner: Science, v. 278, #5344, 1765-1768. [4] Rieder, R., Economou, T., Wanke, H., Turkevich, A., Crisp, J., Bruckner, J., Dreibus, G., McSween, H.Y., 1997, The chemical composition of Martian soil and rocks returned by the mobile alpha proton X-ray spectrometer: Preliminary results from the X-ray mode: Science, v. 278, #5344, 1743-1748.