TERRESTRIAL PYROCLASTIC DEPOSITS AS ANALOGS FOR MARTIAN IMPACTOCLASTIC DEPOSITS. D. M. Burt[1] [1]ASU School of Earth and Space Exploration, Tempe, AZ 85287-1404, dmburt@asu.edu.

Introduction: Early Mars is believed to have possessed both an atmosphere and abundant water in some form. It also was subject to impact bombardment, as evidenced by the remnants of numerous impact craters. Impact cratering continued as an active process after most of the Martian atmosphere had been lost and the Martian surface had frozen and dried out. Therefore the sedimentary record of this bombardment should have been abundantly preserved in the form of impactoclastic layered rocks [1]. These would have been deposited by impactoclastic density currents spreading outwards from impact sites as ground-hugging turbulent clouds (formerly also called impact surge deposits). After deposition, they were locally altered by neutral groundwater and by descending acid condensates. They also could have been heavily etched and eroded by wind.

Similar density current deposits are recognized on Earth mainly in association with explosive blasts, such as volcanic or nuclear blasts, as well as in association with dust storms (haboobs) resulting from thunderstorm downbursts, and as density currents associated with major subsea (turbidity current) or surface landslides. They did not form on the Moon owing to a lack of atmosphere and subsurface volatiles. The layered deposits formed superficially resemble rocks deposited by normal sedimentary processes and have commonly been mistaken for such deposits in the past, both on Earth and probly on Mars [2].

Terrestrial Impactoclastic (IDC) Deposits: Early Earth was subjected to the same sort of impact bombardment as Mars and the Moon, but virtually all evidence has been lost to erosion, metamorphism, and plate tectonics. Younger impacts, such as those at Sudbury, Ontario, Canada, left only remnant patches of basal breccia, or patchy tsunami deposits, or beds of altered spherical accretionary lapilli in ancient marine sediments. Still younger impacts, such as Chicxulub, were clearly marine, or, as at Meteor Crater, AZ, created easily eroded deposits. Such cratering remnants little resemble what might be hoped for on Mars.

Terrestrial Pyroclastic (PDC) Deposits: Although they differ greatly in scale, explosive energy intensity, composition, and other factors, by far the most abundant and accessible terrestrial analogs are provided by explosive volcanism and resulting pyroclastic deposits, especially distal, dilute PDC (Pyroclastic Density Current) deposits [3] [4].

As regards scale, many volcanic explosions, especially those of basaltic maars, are relatively small. Regarding energy intensity, volcanic explosions represent steam explosions, not the far more energetic products of hypervelocity impacts. Regarding composition, most large volcanic explosions are silicic, and even small basaltic maars involve basalts that are much less Fe-rich than on Mars. The relatively Fe-, Cl-, and S-rich nature of the Martian surface implies that impactoclastic density currents with condensing acidic steam clouds could have deposited fumarolic specularitic hematite in accretionary lapilli, as at Meridani Planum on Mars. Finally, regarding other factors, the Martian atmosphere was presumably less dense than that of Earth, and pyroclastic flows on Earth might well be hotter than distal impactoclastic flows on icy Mars.

Despite these shortcomings, and relatively rapid erosion on Earth, terrestrial pyroclastic deposits should share many factors in common with their impactoclastic brethren on Mars, including their generally turbulent nature, that they flow downhill (but can overflow obstacles), and that turbulent vortices could hollow out channels. They also should provide useful textural analogs to impactoclastic deposits in terms of dune forms, low-angle cross-bedding, spherical accretionary lapilli, and other features [5].

Observations and Conclusions: As part of this study, I visited numerous volcanic deposits formed by pyroclastic density currents. Localities, among many others, included Coronado Mesa, AZ, Peridot Mesa, AZ, Koko Crater, Oahu, HI, and Kilbourne Hole, NM. Except for Coronado Mesa, which is the product of large-scale, caldera-style explosive silicic volcanicsm in the Superstition Volcanic Field, the rest are basaltic maars formed by explosive interactions between basaltic magma and groundwater. My conclusion, summarized in more detail elsewhere [6] is that they seem to provide good textural analogs to features observed in layered rocks on Mars and support the idea that these could be IDC deposits.

Acknowledgments: I remain grateful to former coauthors, mentors, and colleagues, including the late R.F. Dietz, M.F. Sheridan, K.H. Wohletz, and L.P. Knauth.

References: [1] Knauth L.P. et al. (2005) *Nature, 438*, 1123. [2] Burt D.M. et al. (2008) *JVGR*, *177*, 755. [3] Wohletz (1998) *in* Freundt, A. and Rosi, A. *From Magma to Tephra*, Elsevier, Ch. 7, 247. [4] Branney, M.J. and Kokelaar, P. (2002) *GeolSocMemoir 27*. [5] Burt D.M. (2021) LPS LII, Abstract #1210. [6] Burt D.M. (2021) *in* GSA Spec. Paper BK631 (Footsteps of W.B. Hamilton, in press).