ASH SOURCES IN ARABIA TERRA? IMPLICATIONS FOR THE ARABIA DEPOSITS. L. Kerber[1], J. R. Michalski[2], J.E. Bleacher[3], F. Forget[1]. [1] Laboratoire de Météorologie Dynamique du CNRS, Université Paris 6, Paris, France (Kerber@lmd.jussieu.fr), [2]Planetary Science Institute, Tucson, Arizona, 85719, USA [3]NASA Goddard Spaceflight Center, Greenbelt, Maryland, USA

Introduction: Arabia Terra contains a number of layered, fine-grained, friable deposits which lie unconformably on top of ancient Noachian crust [1,2]. These deposits are widespread, discontinuous, and often found either as mesas or as crater-fill [2] across a wide range of longitudes in Arabia Terra and Terra Meridiani [1]. It is not clear whether these deposits consist of one, large, widely deposited unit, or if they consist of several different deposits emplaced at different times by different processes [3]. In the west they form mesas and outcrops with even, continuous layering [4]. In the east, the deposit consists of two erosionally distinct terrains, an etched terrain to the north, and a dissected terrain to the south [2, 5-6]. Proposed hypotheses for these deposits include pyroclastic ash [2, 7-8], aeolian dust mantling [1,2,5,6,8], evaporite deposits mixed with cemented clastic materials [9], and paleopolar deposits [10].

Previous modeling of pyroclastic ash dispersal using a variety of volcanic and atmospheric parameters led to the conclusion that it was difficult to produce the Arabia deposits from known volcanic sources [11]. A source can be considered a good match if it can deposit material where it is observed without depositing large amounts of material where deposits are not observed. Explosive eruptions from the Tharsis Montes (or proto-volcanoes of the Tharsis rise) would be able to distribute thin layers of material in Arabia Terra (Fig. 1), but the vast majority of the volcanic output would be expected to accumulate on and around the Tharsis rise itself, especially for ash grain sizes greater than 60 μm, and evidence of these deposits is not observed. Syrtis Major was identified previously as a possible source [2] but simulations indicated that for most atmospheric configurations the majority of accumulation would take place to the east and south of the observed deposit (Fig. 1, [11]), while the observed deposit appears to thicken northward [2]. These findings led to the conclusion that it was unlikely that the Arabia deposits had a significant volcanic ash component [11].

Several features located in western Arabia Terra have recently been proposed as possible volcanic constructs [12,13]. Here we investigate whether ash erupted from these proposed volcanic sources would provide a better match for the Arabia deposits.

Approach: The ancient martian atmosphere was modeled using a generalized planetary model developed by the LMD to model the early martian atmosphere and the atmospheres of exoplanets [14,15,16]. This model uses a fully-developed radiative-transfer scheme to more accurately model energy exchange in higher pressure atmospheres. For this investigation, the pressure in the model was varied between 7 millibars and 2 bars [see 16]. The simulations were run for one year as a way of averaging out the effects of seasonal winds [11]. The one-year eruption is therefore a proxy for dozens of shorter eruptions that might have taken place over hundreds to millions of years during random seasons. The total volume of the eruption was taken to be the volume of the Arabia deposits as given by [3]. The pyroclasts dispersed in these simulations are 35-μm in radius, representative of small, far-field ash. The chosen source point was the feature identified by [13] as Eden Patera, though eruptions from other nearby proposed volcanic features would not produce a significantly different dispersal pattern.

Results: A source located on the western edge of Arabia would greatly improve the fit between simulated ash dispersal and observed deposit thickness compared to simulated distributions from other known volcanoes, as ash in these latitudes is generally transported eastward by dominant high-level winds (Fig. 2). If the proposed volcanic sources are indeed explosive centers, their eruptions could have easily provided fine-grained material which could fill craters or be cemented and incorporated into sedimentary rocks. The area of greatest accumulation from an eruption of Eden Patera would be in northwest Arabia Terra, instead of in northeast or southwest Arabia Terra, where the deposits are observed to be most continuous [17], though eruptions from more eastern proposed sources [13], would disperse ash throughout northern Arabia Terra. To avoid a large accumulation near the vent (which is not observed), the eruption would have to be powerful and the ash would have to be fine-grained. Alternatively, ash could have been originally deposited closer to the vent and then redistributed by the wind over several billion years, a process which would tend to flatten any gradient over time. Other, unrecognized vents may also exist. Expanding the search for ancient explosive centers will be important for refining our understanding of the production of fine-grained materials in this area and across Mars.

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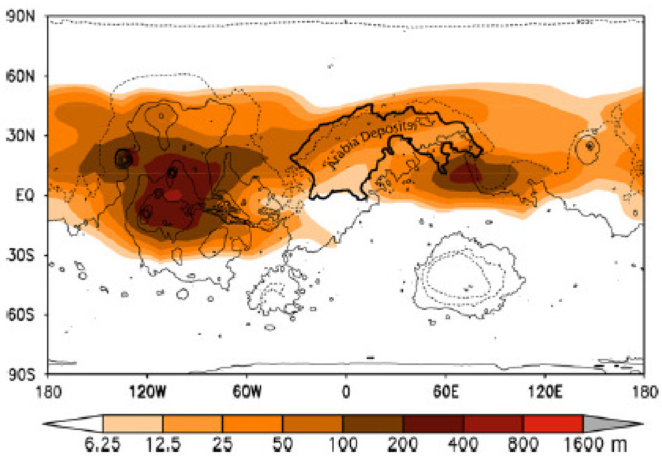

Figure 1. Figure from Kerber et al., 2012 [11] showing the accumulated surface ash (in meters) from known volcanoes surrounding Arabia Terra. None of these volcanoes deposits a significant amount of material where accumulations are observed.

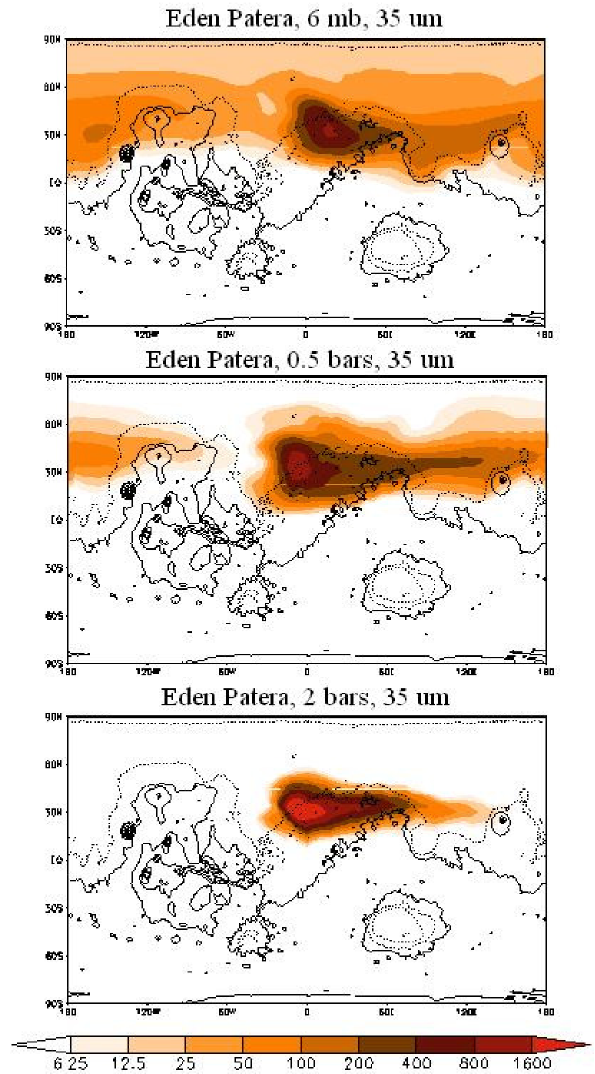

Figure 2. Simulated cumulative eruption patterns for different pressure regimes from proposed volcanic source Eden Patera [13], in meters of surface accumulation.