FLUIDIZED EJECTA BLANKETS ON MARS: ESTIMATE OF MATERIAL PROPERTIES. B.A.Ivanov[1], A.V.Pogoretsky[1], and B.Murray[2], [1]Institute for Dynamics of Geospheres, Russian Academy of Sciences, Leninsky Prospect 38-6, Moscow, Russia 117939 (baivanov@glasnet.ru), [2]California Institute of Technology, Pasadena, CA 170-25 (bcm@earth1.gps.caltech.edu).

Summary. We continue to study the nature of the Fluidized Ejecta Blankets (FEB) around Martian craters. Previously we assumed the model of hydrodynamic outflow of ejecta after deposition [1, 2, 3]. We use the Bingham rheology as a mean to compare mass motion of various nature. We demonstrated [2] that Bingham parameters (cohesion and viscosity) for the FEB material should be smaller than similar parameters for terrestrial dry rock avalanches but larger than for typical lahar's Bingham parameters. In the presented paper we make an attempt to move toward the quantitative interpretation. The current model treats the FEB material as a mixture of "volatile-rich" material (VRM) and dry rock debris. Comparing the modeled ejecta runout with observations we arrived to several conclusions:

1. The ratio of the outer FEB radius to the crater radius, R_m/R_r, would increase even for constant VRM percentage due to the scale effect.

2. The R_m/R_r ratio is sensitive to the flow geometry: radially divergent flow stops earlier than a quasi-parallel flow. Radial inhomogenity of the flow field may be responsible for the lobateness of the FEBs.

3. The preliminary estimate shows that Bingham parameters of the VRM (during the ejecta deposition) are: cohesion (divided by density) from 0.1 to 1 m^2s^{-2}, kinematic viscosity from 0.01 to 0.1 $m^2 s^{-1}$.

Introduction. The typical values of fluidized ejecta runout, R_m/R_t, from 3 to 6 correspond to the Binham parameter's field just between dry rock avalanches and water-saturated debris flows on Earth. The result gives a support to the hypothesis of the ejecta mobility resulted from an incorporation of volatile-rich material (VRM) into ejecta. While the model will be more advanced, such a comparison seems to allow more reliable evaluation of the volatile content and their physical state from Viking imagery.

FEB material as a suspension.

In this paper we use a simple assumption that the fluidized ejecta material may be treated as a uniform mixture of ejected rock fragments and VRM. Thus the effects of a two-phase flow and a phase separation are still beyond the scope of the current model. Nevertheless we believe that one needs to make this step before incorporation of more complex phenomena into the model.

The mixing model is based on the well-known Z model of cratering. We can estimate the depth to the volatile-rich layer from the published data (see, for example, [4]). It gives us a possibility to estimate the percentage of the volatile-rich material in the ejecta. Using the known theory of dense suspension (see, for example [5, 6] one can estimate the Bingham parameters for the VRM, treating the FEB flow as a mixture of VRM with "dry" ejecta from upper layers.

To make preliminary estimates we used experimental data [6] about the shear flow of suspensions of glass beds and the Mount St. Helens material, presented in [6] in the form of Bingham parameters.

The model of FEB deposition was presented earlier [2,3]. Here we used analytical approximation of our previous numerical simulations. The system of estimates was constructed to couple (I) Bingham parameters of VRM and VRM/"dry" ejecta mixtures, (2) scale relationships for cratering and ejecta deposition, and (3) observed runout characteristics. We used generalized relationships proposed by Mouginis-Mark [8] and Cave [9]. The best fit was found for the VRM Bingham parameter's range: cohesion (divided by density) from 0.1 to 1 m^2s^{-2}, kinematic viscosity from 0.01 to 0.1 $m^2 s^{-1}$ for the dry overburden of 0.5 to 1 km at the moment of the impact event. These values are in the range of parametres for dense and viscouse terrestrial mud or a clay with a low plastic limit.

The modeled runout for hypothetical area with VRM at the depth larger than 500 m was calculated for craters in the diameter range 5 km (the FEB onset) to 40 km. Fig. 2 and 3 show the absolute and relative runout for aforementioned range of the VRM Bingham parameters.

Divergent versus no-planar flow. We tested the model, calculating the planar flow of the initial rim/ejecta uplift to find the difference in runout of the divergent (radial) and planar FEB flow. The difference was found to be of the order of 10%. One suppose that in the real flow nonuniform sectors of flow may be generated. If so, the flow in sectors with less divergence may be resulted in large runout, giving the possible explanation to the observed lobateness of Martian FEBs. This gives one more approach to test the proposed model in future.

Scale effects. The scaling of the FEB model, presented in [3] clearly shows that even for the same model parameters (which may be interpreted as widely cited "ice content" - see [4, 12]) the relative runout increases with the crater diameter. Fig. 3 illustrates it for the simulated runout of the pure VRM material.

Discussion. The proposed model seems to give reasonable explanation to the main features of FEBs. Nevertheless it still uses only runout data. Morphology diversity of FEBs (see, for example, [10, 11]) is the challenge for future study. The existed databases (like in [12]) also may be used for the future model test.

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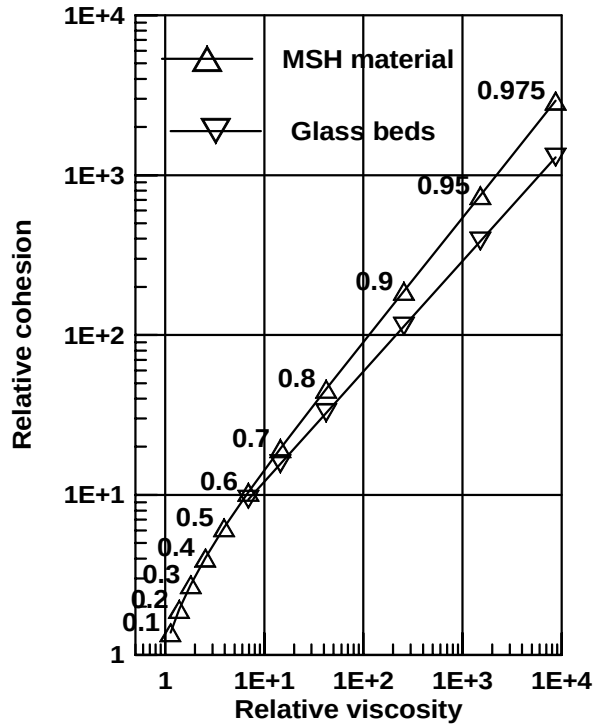

Fig. 1. Relative cohesion as a function of relative viscosity for a dense water suspension of glass beds and the material of Mount St.Hellens mudflow (modified from [7]. Numbers on the plot show the concentration of solid material relative to the dense packing.

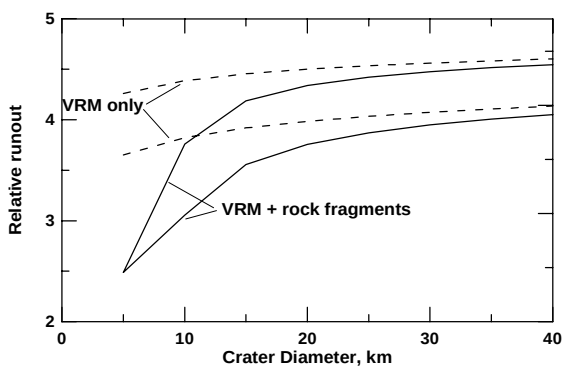

Fig. 2. The modeled outer FEB diameter as a function of crater diameter. Solid lines limit the range of possible runout for maximal and minimal assumed Bingham parameters for VRM. Dashed lines illustrate the runout of pure VRM without loading with rock fragments.

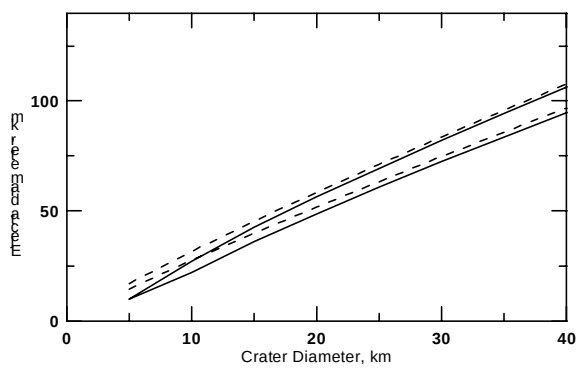

Fig. 3. The same as on Fig.2, but for relative runout (outer diameter of a FEB, divided by crater diameter).