DESTRUCTION OF ROCKS BY LOW VELOCITY IMPACT.

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We have been conducting low velocity (50 ∿ 500 m/sec) impact experiments on rocks to clarify a nature of collision process of planetesimals (Matsui et al., 1982; Waza et al., 1983). Impact velocity, material property, relative size and mass, and configuration of colliding bodies were the important parameters controlling the low velocity impact phenomena. Boundaries marking the transition between collision types such as rebouncing, and longitudinal splitting and catastrophic destruction of target were functions of the above parameters. However, the relations between them are rather complex and so only the qualitative results were reported in the previous papers. In this study we give more detail analysis on the relations between them. (describing

The largest fragment mass M_ℓ has been used as a parameter) the collison types quantitatively: for example, $M_\ell/M_t \sim 1$ for rebouncing, $1 \gtrsim M_\ell/M_t \gtrsim 0.2$ for longitudinal splitting, and $M_\ell/M_t \ll 0.2$ for catastrophic destruction, where M_t is a target mass. M_ℓ/M_t is related to imparted energy density E_i which is defined by released kinetic energy divided by the target mass. M_ℓ/M_t is plotted against E_i in Figs. 1 and 2. Open and solid symbols in the figures represent spherical and cubic targets, respectively. The M_ℓ/M_t versus E_i relation seems to be dependent on impact velocity. As shown in Fig. 1, the relation derived from the high velocity (∿2 km/sec) impact experiment (Fujiwara et al., 1977) is clearly deviated from our data points. Configuration of target also affects the relation. As seen in Figs. 1 and 2, solid symbols are mostly distributed below open symbols. However, effect of difference in configuration of target on the relation is not so large. The most interesting result is that irrespective of large difference (about one order of magnitude) in compressive strength between tuff (∿27 MPa) and basalt (∿220 MPa) we cannot see any clear difference in the M_ℓ/M_t versus E_i relation between them. If we plot the data for ice reported by Lange and Ahrens (1981), they are distributed in the much left region in these diagrams. In this respect we can see a strength effect on the M_ℓ/M_t versus E_i relation. Because compressive strength of ice is about similar to that of tuff. However, as experimental conditions of Lange and Ahrens are different from ous we cannot compare both results equally. Then, we keep from going into details on this problem until we complete low velocity impact experiment on ice. The M_ℓ/M_t versus E_i relations fitted by a least square method are given as follows: $M_\ell/M_t = 5.1 \times 10^4 E_i^{-0.81 \pm 0.05}$ for spherical basalt, $M_\ell/M_t = 5.8 \times 10^3 E_i^{-0.70 \pm 0.14}$ for cubic basalt, $M_\ell/M_t = 7.6 \times 10^3 E_i^{-0.68 \pm 0.05}$ for spherical tuff and $M_\ell/M_t = 1.3 \times 10^3 E_i^{-0.62 \pm 0.08}$. Size distribution of fragments is well expressed by an inverse power law relation, $n(\ell)d\ell \propto \ell^{-\alpha-1} d\ell$, where $n(\ell)$ is an incremental number of frragments within the size range of ℓ to $\ell + d\ell$. The slope of the size distribution seems to become steep with increasing the imparted energy density. In Fig. 3,

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the exponent α for the catastrophic destruction of basalt sample is plotted against E_i. We can see a clear tendency of increasing α with increasing E_i: $\alpha \sim -0.6 + 0.36 \log E_i$. However, we cannot see such tendency for tuff. α for the catastrophic destruction of tuff sample is almost constant against E_i. It probably means that the imparted energy density is high enough to cut off the bonding of each pair of grains composing tuff. As mentioned by Waza and Matsui (this volume), for basalt number of very fine fragments increases with increase in E_i but not for tuff. This observation supports the above view.

References: Fujiwara, A. et al. (1977) Icarus 31, 277-288. Lange, M. A. and Ahrens, T. J. (1981) Proc. Lunar Planet. Sci. 12b, 1667-1687. Matsui, T. et al. (1982) J. Geophys. Res. (in press). Waza, T. et al. (1983) submitted to J. Geophys. Res..

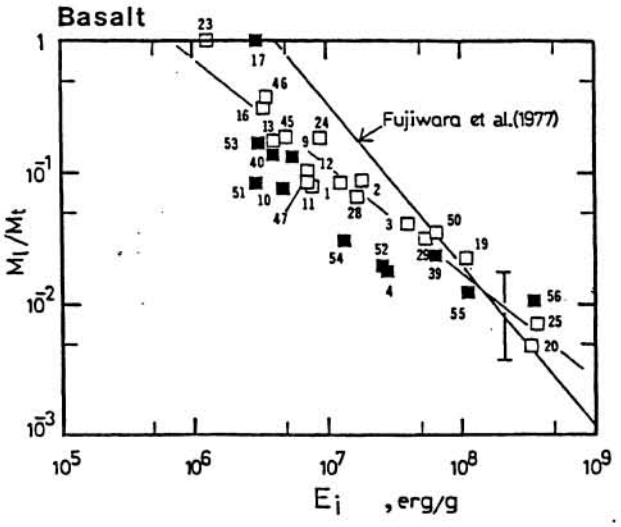

Fig. 1

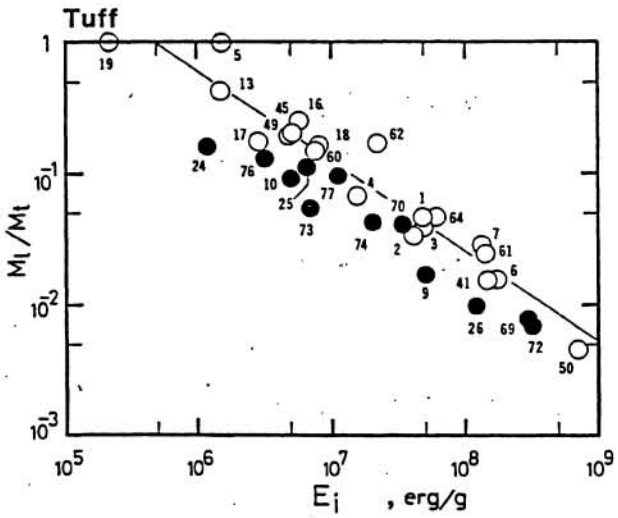

Fig. 2

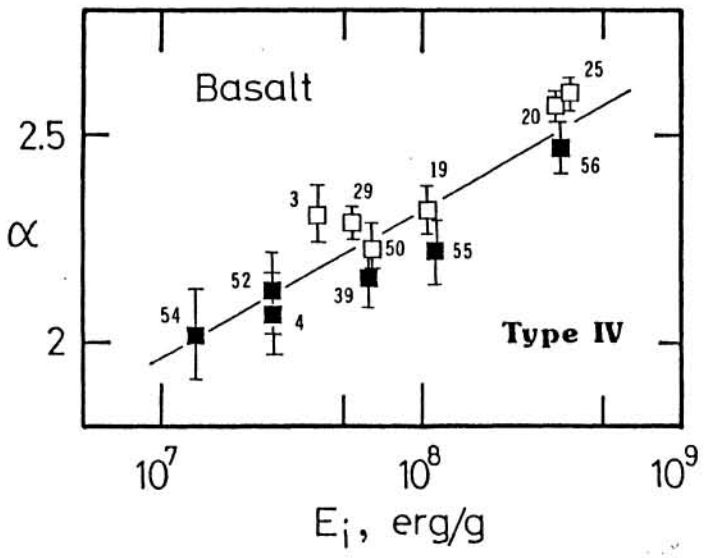

Fig. 3

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