MICROCRATERS OBSERVED ON 15015 BRECCIA AND MICROMETEOROID FLUX. J.-C. Mandeville, ONERA/CERT, 2 Ave. E. Belin, BP4025 31055 TOULOUSE CEDEX, FRANCE.

As a co-investigator of Dr. A. Dollfus we present here results of the study of a sample from the 15015 breccia. It has an extensive dark glass coating probably formed by melting phenomena associated with the ejection of the rock to its present site (1). The breccia has been made by various constituents of the local soil, 3 by. ago; the glass coating is younger (1,2 by. old).

However, after formation 15015 was buried at a depth greater than 2 meters until it was ejected on to the lunar surface recently, as suggested by:

- the low solar flare track densities
- the low density of craters produced by micrometeoroid impacts

We scanned an area of 0.16cm², chosen in a smooth glassy zone of the sample, using a SEM at 100X and 300X magnifications. We find craters with diameters between 450 and 20 μm. These craters all show a morphology typical of craters produced on glass targets by projectiles with velocities higher than 10 km/s: central hemispherical smooth pit, with evidence of melting, surrounded by a spallation zone; the spalls are totally ejected for craters with diameter greater than 50 μm.

The mass of the micrometeoroids is deduced from craters dimensions using the calibration curves presented in fig. 1. The curves present the results of many experimental studies on hyper-velocity impact (5-8). It is assumed an impact velocity of 20 km/s and a meteoroid density of 3 g/cm³.

Experimental studies also show that most micrometeoroids have densities in the 2-4 g/cm³ range:
- The mean value of the Ds/Dp ratio (3.5) is close to the value obtained in experimental impacts with aluminium projectiles (8).
- The value of Ds/d and Dp/d ratios is also close to that obtained in laboratory experiments (typical values 12 and 4 respectively).
- The depth to diameter ratio of the craters; P/Dp, is consistent with projectiles whose density lies in the 2-3 g/cm³ range (aluminium).

Fig. 2 displays the crater size frequency distribution, this distribution is typical for lunar glass surfaces.

With the calibration curves of fig. 1 we can derive micrometeoroid masse from measured crater diameters and compute micrometeoroid flux in a given mass range, if we know the exposure time of the sample to meteoritic bombardment (by solar flare track density for instance), or vice-versa.

Micrometeoroid fluxes are presented in fig. 3. The upper curve is derived from satellite detectors measurements; the lower
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curve(4) shows the micrometeoroid flux (average over the past $10^4$ - $10^5$ years) derived from lunar samples analyses. The present flux, however, would be greater as shown by the dotted curve plotted after G. Neukum for samples with recent exposure time(2). The solid curve shows the micrometeoroid flux derived from our analysis of breccia 15015,15,23,3). We assumed a 2000 years exposure time on the lunar surface.

This value is consistent with a measured solar flare track density of $5 \times 10^7$ tracks/cm$^2$ at 10 µm depth (11). According to the studies of J.B. Hartung et al. (2) and D. Stürzer et al. (3), the solar flare track production rate is $3 \times 10^4$ tracks/cm$^2$/year (10 µm depth). They find also a crater density of 80/cm$^2$ (with diameter D$_p$, greater than 20 µm) for a track density of about $5 \times 10^7$/cm$^2$; the corresponding particle flux, with masses greater than $2.5 \times 10^{-10}$g, is found to be $1.3 \times 10^{-5}$/m$^2$/s. These results are in good agreement with our analysis.

In summary, the sample under study has been exposed to meteoritic environment for a relatively short time and the value of micrometeoroid flux we found is close to the value given by Neukum (10).

5. D.E. GAULT - The Moon, 6, 32-44, 1973
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Fig. 1

Fig. 2

Fig. 3
COMPARATIVE $^{238}\text{U}-^{206}\text{Pb}$, $^{235}\text{U}-^{207}\text{Pb}$, $^{232}\text{Th}-^{208}\text{Pb}$, $^{206}\text{Pb}-^{207}\text{Pb}$ and $^{87}\text{Rb-87Sr}$ AGES OF BASALTIC ACHONDrites AND EARLY EVOLUTION OF THE SOLAR SYSTEM.


$^{87}\text{Rb-87Sr}$ internal isochrons obtained for Juvinas, Sioux County and Ibitira have an age of 4.55 b.y. (1, 2). On the contrary, those for Bereba, Stannern and Pasamonte show disturbance of Rb-Sr systems at 4.3, 3.35 and 2.6 b.y. ($^{87}\text{Sr}/^{86}\text{Sr}$) ratios are consistent with metamorphic redistribution in those perturbed objects and with the fact that some of them have a record of fissionogenic Xe produced from $^{238}\text{Pu}$ (3). Total-rock Rb-Sr isochron obtained here defines an age of 4.5 ± 0.1 b.y., being consistent with the previous studies (4). Angra dos Reis falls outside the line with a different initial $^{87}\text{Sr}/^{86}\text{Sr}$ ratio of 0.69877 (in agreement with Papanastassiou et al. (5)). Using a new chemical technique with blank as low as 0.2 ng lead, U-Th-Pb studies were made on total rocks of Juvinas, Bereba, Ibitira and Stannern. Comparison with the previous studies on Sioux County, Nuevo Laredo and Angra dos Reis (6) permits to define a concordant age of 4.55 b.y. (using the new decay constant for U) for Nuevo Laredo, Juvinas and for Sioux County. Bereba and Stannern, in contrast, give a discordant and low age consistent with Rb-Sr results (4.3 and 3.35 b.y., respectively). Pasamonte gives a discordant and high age. The radiogenic character varies from one sample to another, ranging from $^{206}\text{Pb}/^{204}\text{Pb}$ ratio of 240 to 70. The radiogenic character of lead is correlated with that of strontium as it is for lunar and terrestrial rocks.

An interpretation of the results is that the primary chemical differentiation of the parent body for basaltic achondrites occurred at 4.55 b.y. ago, and subsequent impacts, metamorphism and brecciation disturbed the parent-daughter systems. We have no evidence of chemical differentiation since 4.55 b.y., which does not support the argument given by Papanastassiou et al. (7) based on the Rb-Sr systematics of Kapoeta.

References: