N92-12905

DEGRADATION STUDIES OF MARTIAN IMPACT CRATERS. N. G. Barlow, SN21, NASA/Johnson Space Center, Houston, TX 77058.

Martian impact craters display a variety of preservational characteristics, ranging from very fresh to extremely degraded (1). This range in degradation states has led to numerous theories describing spatial and temporal variations in the martian obliterative history (2, 3, 4). These previous obliteration studies have relied on qualitative descriptions of martian impact crater degradation. The present study is quantifying the amount of obliteration suffered by martian impact craters by comparing measurable attributes of the current crater shape to those values expected for a fresh crater of identical size.

Crater diameters are measured from profiles obtained using photoclinometry across the structure. The relationship between the diameter of a fresh crater and the crater depth, floor width, rim height, central peak height, etc., have been determined by empirical studies performed on fresh martian impact craters (5). The corresponding values for the actual craters are measured using photoclinometric techniques (6). Errors are on the order of 5% for the photoclinometric analysis and 15% for the pristine crater estimated values. A comparison of present value to pristine value gives an estimate of the percentage change which the attribute has undergone.

In this study, we have utilized the changes in crater depth and rim height to judge the degree of obliteration suffered by martian impact craters. Initial analysis is concentrating on the proposed landing sites for future Mars surface missions (7) located within ±40° of the equator. Five sites have been analyzed to date using Viking Orbiter images of approximately 40 m/px resolution: one in the heavily cratered Arabia region and four located in various regions of the outflow channel Maja Valles. The analysis finds that crater depth values vary in a more systematic way than do rim height variations. Regional mapping of crater depth variations suggests that we can discern finer distinctions between areas of degradation than have been noted previously. Three of the five sites studied are in areas where the surrounding craters are highly degraded, suggesting that materials are likely to be very weathered in these regions. Two of the sites in Maja Valles are located in areas where crater depths are within 30-40% of their pristine values, indicating moderate amounts of obliteration. In terms of the martian relative chronology, the Arabia region dates from the period of heavy bombardment and the Maja sites formed during the post heavy bombardment period (8), indicating that a constant obliteration rate cannot explain the observed results. Slight variations in measured values among different sites are being studied for possible clues to variations in target characteristics and/or obliterative processes. This study will not only provide better information on the expected conditions at the proposed Martian landing sites, but also allow a more detailed analysis of the obliteration history of the planet.

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THE S-CLASS ASTEROID DEBATE: HISTORICAL OUTLINE

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The longest running argument in asteroid science concerns the mineral composition and meteoritical association of the asteroids assigned to taxonomic type S. Over the past 20 years this controversy has occupied an immense number of abstracts, funding proposals, telescope time requests, progress reports, workshop preceedings, Arizona "Blue Book" chapters, NASA SPs, CPs, TMs, JPL internal documents, and occasionally even refereed journal articles. Below are summarized the various proposed S asteroid surface compositions in roughly the order in which they appeared.

A) ORDINARY CHONDRITES: It was known long before asteroid spectroscopy began that ordinary chondrites (OCs) make up more than 75% of observed meteorite falls. Some meteoriticists of the 1960s came to believe that these fall statistics must reflect the proportions of meteorite parent bodies in the asteroid belt. Discovery of implanted solar-wind gases in OCs established that they had an extensive regolithic history at roughly the belt's solar distance (1), and that OC clasts were the second most common type of exotic material in meteorites (2). Thus when the first asteroid colors and albedos were obtained in the early 1970s there was a strong expectation that many asteroids would resemble OCs. Inevitably, when the early observations revealed an abundant class of asteroids with silicate absorption bands and OC-like albedos, many meteroriticists assumed that these were the OC parent bodies. Indeed, the spectral class "S" originally was intended to stand for "silicaceous" as "M=metal" and "C=carbonaceous" (3). Thus the original Big Three asteroid types neatly accounted for ordinary chondrites, irons, and carbonaceous chondrites. This view never gained universal support among spectroscopists since at the time there were few high-resolution spectra of asteroids and essentially none of meteorites. Indeed, 20 years later the meteroritical basis of this theory has been challenged by the discovery that OCs are virtually absent from the micrometeorites recently recovered in Antarctic and Greenland ice (4).

B) STONY-IRONS: Later, when spectra of ordinary chondrites were measured in the lab (5) it became apparent that they actually had little similarity to S asteroids other than having olivine and pyroxene absorption bands. The asteroid spectra slope steeply upward toward the red while OC spectra are flat, and the details of the silicate bands vary wildly, implying mineralogies usually far outside the OC range (6). To explain these facts it was suggested that most S-type surfaces are differentiated assemblages of metal, orthopyroxene, and olivine, similar to stony-iron meteorites such as pallasites and lodranites (7). This material would be the product of melting in the deep interiors of the asteroid parent bodies, subsequently exposed by the collisional disruption. Advocates of this hypothesis have proposed various alternate source bodies for OCs. Probably the least objectionable of these is the Q-class asteroids (8), which conveniently are all tiny Earth-crossing asteroids with low-quality spectra. But current collisional models of the asteroids require that this population be constantly replenished from a reservoir in the main belt, where no Q-types have been found.

C) WEATHERED ORDINARY CHONDRITES: Upon discovery of the continnuum slope problem, advocates of interpretation A) proposed that the red continuum of S asteroids is created by some "space weathering" process which alters the spectrum of the uppermost regolith. Usually they propose that this is associated with the metal component of chondrites, because it is obvious that pure-silicate asteroids of classes V, R, A, and E do not have any reddening. This proposal has inspired investigations of both synthetic metal-rich regoliths derived from OCs (9) and natural OC parent body regolith material preserved in some meteorite breccias (10). All these studies demonstrate that "weathered" OC material does not redden, but rather becomes spectrally flatter and in extreme cases approximates a C-type spectrum, never an S-type. In fact this similarity leads some to propose that the OCs actually come from C-type asteroids (11).

D) CARBONLESS CARBONACEOUS CHONDRITES: When the first near-IR spectra of S asteroids revealed that most had higher ol/pyx abundance ratios than any OC, it was proposed (12) that they represented unknown types of chondrites, specifically material with the silicate composition of carbonaceous chondrites but no carbon. But since no such meteorites have ever fallen on Earth, this hypothesis requires its advocates to abandon the very fall-statistics argument that had originally inspired the chondritic interpretation of S-types in the first place. Furthermore, the asteroid Flora which was cited in (12) as the most OC-like of the S-types in terms of ol/pyx abundance ratio was later shown to have large variations in silicate mineralogy between different regions of its surface, unlike the trends found in chondrite classes (13). As a result, this hypothesis is almost forgotten, except by die-hard supporters of interpretation A) above who mistakenly cite (12) as supporting them.

An alternate explanation of the excess of olivine observed in most S-astreroids is that differential comminution of olivine and pyroxene grains during regolith gardening causes the two minerals to assume different particle sizes. Synthetic regoliths created by laboratory impacts (14) show that such an effect is small, and would act in the wrong direction to account for the S-asteroid/ OC discrepancy.

E) EVERYTHING: The mounting spectral evidence for wild variations in composition between different S asteroids and even across the surface of individual ones (15) leads some workers to wonder if both schools might be right. It is impossible to rule out some chondritic areas on the surfaces of S asteroids with the current data, if one allows some other areas to be made of extreme differentiated mineralogies (e.g. pure metal or pure olivine). Since we observe an entire "hemisphere" at once with Earth-based telescopes the chondritic areas could not be separated from the differentiated areas. Current ideas about asteroid differentiation lean toward such a complex pattern of heating. The fatal objection to this theory is that the actual OC breccias do not contain differentiated clasts, which would be sure to exist in the regolith of a "patchwork asteroid".

F) NOTHING: Alternatively one may take the wide variety of S spectra to indicate that there is really no such thing as a unified "S-type asteroid", but a variety of different objects with different origins and histories which we have not yet properly distinguished. For instance, the Eos asteroid family contains objects formally classified S in most systems, but with IR spectra that closely match those of CO or CV chondrites. A new class "K" was recently created to contain these objects (16). But this probably does not herald the beginning of the end for Class S. There does seem to be a hard core of well observed objects with classical S properties that will always remain even if some of the fainter objects which have only incomplete spectral data later turn out to be something else.

THE CURRENT POSITION: At present almost all scientists actively involved in research on asteroid composition appear to hold some version of interpretation B. In fact, no full journal article defending any other view has appeared for at least 10 years (the closest approximation being (17)). Yet some of them (especially C) continue to be defended vigorously in less formal situations. None can be rigourously excluded on the basis of current data, and very little new data is being collected due to funding and personnel shortages.

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SIZE-DEPENDENT COMPOSITION IN THE METEOROID/ASTEROID POPULATION: PROBABLE CAUSES AND POSSIBLE IMPLICATIONS. **Jeffrey F. Bell** (Planetary Geosciences Division, Dept. of Geology and Geophysics, Univ. of Hawaii at Manoa, Honolulu HI 96822)

Much evidence suggests that the meteorite/asteroid population exhibits a marked change in mineralogical composition with size, and that this variation is correlated with mechanical properties of the material. Consider the following four size ranges of projectiles striking the earth within the last million years:

1) Crater-forming projectiles (≥5000kg): All meteorite fragments found in association with recent observed craters are irons (~10) or stony-irons (~3) (1).

2) Non-Antarctic meteorite falls (~5kg): As is well known, this population contains only 15.6% irons and stony-irons, while there are 72% ordinary chondrites, 9.4% achondrites, and 3.1% carbonaceous chondrites by weight (2).

3) Antarctic meteorite finds (~10gm): The average size of this population is smaller that the traditional meteorite population, due to the careful search methodology employed and the ease of recognising small meteorites against the blue ice background. This population is 5.8% irons, 88.6% ordinary chondrites, 3.1% achondrites, and 2.5% carbonaceous chondrites by weight (2).

4) "Cosmic spherules" (~0.001gm): This population of 0.1-1mm particles found in Antarctic and Greenland ice has attracted considerable attention because studies of atmospheric entry heating show that particles in this size range cannot survive entry on typical cometary orbits. Therefore they should be of purely asteroidal origin, unlike the smaller (<10μm) stratospheric dust particles whose origins continue to be controversial (3). Furthermore, objects of this size range can be brought in from anywhere in the asteroid belt by Poynting-Robertson drag, while conventional meteorites are thought to come from narrow regions of resonant or chaotic orbital behavior. These arguments recently led to detailed studies of large numbers of these patrticles in the hope of seeing an unbiased sample of asteroid composition. Contrary to all expectations, this population was found to be predominantly CM chondrites (4).

The trend is clearly for increasingly smaller size fractions to be more dominated by mechanically weaker materials, suggesting that differential fragmentation is the cause. But is this fragmentation in space due to collisions with other particles, or fragmentation in the Earth's atmosphere? Several lines of evidence suggest that at least a significant portion of the effect must be due to collisions in space. Virtually the first result of lunar regolith studies was the discovery of a ubiquitous component of CI or CM material in the intercrater lunar regolith, attributed to gardening by carbonaceous chondrite dust (5). However, later studies of regolith or breccias derived from specific macroscopic impacts on the moon usually identified OC or iron meteorites as the projectiles. In addition, the much greater cosmic-ray exposure ages of irons versus chondrites has traditionally been attributed to increased resistance to collisions in space.

This concept has some interesting implications. First, the obsessive search by asteroid spectroscopists for an abundant class of ordinary chondrite asteroids is based on the historical accident that "classical" hand-sized meteorites were the first asteroidal samples to be studied in detail, which created the false impression that space was filled with OC material at all sizes. Second, since this idea "contradicts 20 years of work on asteroid colllisional models" (C. Chapman, personal communication) the fundamental assumptions of these models must be reevaluated. For instance, the mechanical strengths assumed in these models are usually uniform for all projectiles and targets, and the values selected are often based on studies of basalt or dunite, both very rare in the modern asteroid belt. There is a need for collisional models which incorporate realistic mechanical properties for both different orbital zones and different layers in differentiated asteroids.

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THERMOLUMINESCENCE AND C-14 OF NON-ANTARCTIC METEORITES: TERRESTRIAL AGES OF PRAIRIE STATE FINDS. **P.H. Benoit[1], Lu Jie[1], A.J.T. Jull[2], and D.W.G. Sears[1].** [1]Cosmochemistry Group, Dept. of Chemistry and Biochemistry, University of Arkansas, Fayetteville, AR, 72701 USA. [2]NSF Accelerator Facility for Radioisotope Analysis, University of Arizona, Tucson, Arizona 85721, USA.

Radiocarbon analysis has proved of great value for terrestrial age determinations for most non-Antarctic finds (<~40,000 years) as demonstrated, for instance, by recent work on Roosevelt Country meteorites (1-2). In theory, the decay of natural thermoluminescence (TL) should also be useful for terrestrial age determinations, although the decay rate is a function of storage temperature (3). Comparisons of C-14 terrestrial ages and natural TL levels for Prairie State meteorites made a decade ago showed a suggestive but rather poor correlation (4-5). Recently, new radiocarbon measurements were made using accelerator mass spectrometry, and we have also obtained new TL data for about half of these samples (6).

Our new TL data confirm the earlier data (4) within instrumental uncertainties (< size of the symbols in Fig. 1), but many of the earlier radiocarbon dates appear to have been in error. Fig. 1 shows the TL data plotted against the new AMS C-14 data. Also shown in Fig. 1 are the theoretical 2nd-order TL decay curves for 0 and 20 ^{o}C using the TL parameters for Lost City (3). The correlation between natural TL and ^{14}C terrestrial age is now much improved over the earlier work. The experimental data seem to follow the curve expected for an effective theoretical storage temperature slightly less than 20 ^{o}C. Only Brownfield deviates markedly from this trend. It has apparently experienced a higher average storage temperature than the other meteorites, or has had an otherwise unusual thermal terrestrial history.

We also report data on a possible new Prairie State meteorite which was recently brought to our laboratory. We are presently undertaking its characterization and conducting a search for historical documentation, but it was apparently found by paleontologist H.T. Martin in the Kansas region at about the turn of the century. Initial work seems to indicate that it is L or LL of type 5-6. The stone, although fairly rusty, possesses an extensive scalloped fusion crust surface. Its natural TL level is 7.6+-0.1 krad, approximately equal to Keyes, which, in consideration of Fig. 1, indicates a terrestrial age of >10,000 years.

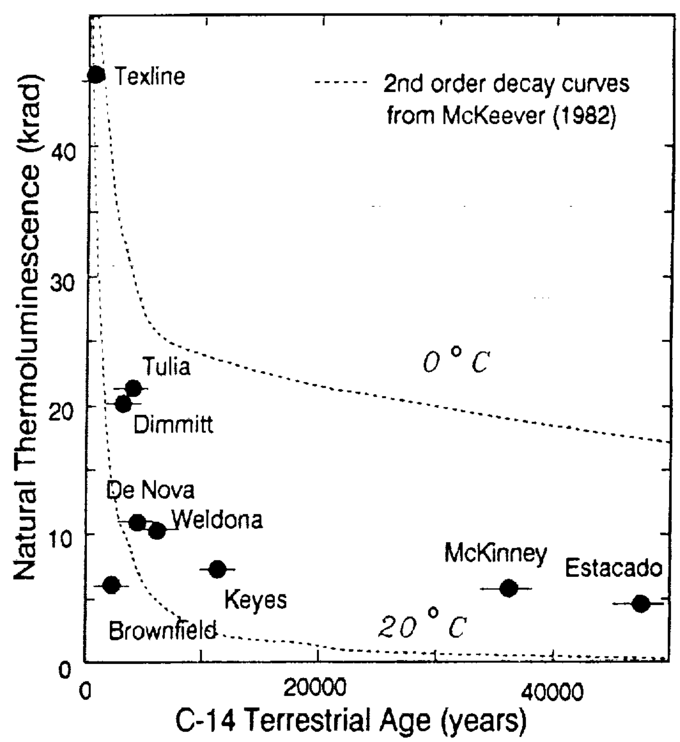

Fig. 1. Natural TL compared with terrestrial ages determined by AMS measurements for ^{14}C.

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ICE MOVEMENT, PAIRING AND METEORITE SHOWERS OF ORDINARY CHONDRITES FROM THE ALLAN HILLS. **P.H. Benoit**, H. **Sears**, and **D.W.G. Sears**, Cosmochemistry Group, Dept. of Chemistry and Biochemistry, University of Arkansas, Fayetteville, AR 72701.

Almost two thousand meteorites have been returned from the Allan Hills region of Antarctica in the last decade or so (1). Since 1987, as part of the initial characterization of these meteorites, we have conducted a routine thermoluminescence (TL) survey of all returned samples large enough (>20g) for the technique (2-3) and we have also recently measured 50 EUROMET samples. We report here conclusions based on TL data for 161 meteorites from the Main, Far Western (FW) and Near Western (NW) ice fields at the Allan Hills.

We have investigated the degree of pairing in this dataset using fairly conservative criteria based on petrographic descriptions, find location, and natural and induced TL. We have identified 33 pairing groups (with 2-5 members), suggesting that our dataset contains a maximum of 123 individual meteorites.

The natural TL of meteorites from the Main field is generally low (5-30 krad), in agreement with the high terrestrial age for this field (4). The natural TL of meteorites from the NW and FW are, however, generally high (30-80 krad) in agreement with Huss' suggestion, based on meteorite concentrations, that these fields are much younger than the Main field (5). At all three fields there is a tendency for meteorites with low natural TL to be found down ice, suggesting that the Whillans-Cassidy mechanism for meteorite concentration is applicable to individual icefields as well as on a regional scale.

The induced TL sensitivity of the Allan Hills meteorites are generally lower than those of non-Antarctic falls which is either largely or wholly the effect of weathering (6). The induced TL peak temperature-width data of H-chondrites, which are not affected by weathering, show a broad range in temperature which differs significantly from the non-Antarctic falls and portions of the Lewis Cliff field (7). This suggests that at least a portion of the older Antarctic meteorites have experienced different thermal histories than younger Antarctic meteorites and modern falls as was noted earlier (8).

The 1988/89 German-American expedition (9) discovered a number of meteorites in a previously barren area along the escarpment west of the major meteorite concentration at the Main field. Ten of these are H5-6 chondrites ([ALH88026, 88030, 88033, 88035], [88029, 88042], [88018,88042], 88016, 88017) with atypically high (>100 krad) natural TL. Although our conservative pairing criteria separate these meteorites into three pairing groups and two unpaired samples, we think it likely that all ten are actually paired. This group is noteworthy for its extremely high natural TL, higher than most non-Antarctic falls. The fairly high degree of weathering indicates that the group is not a modern fall but its high natural TL and the number of fragments indicates that it is certainly younger than most Antarctic meteorites. The shower mmust have experienced an unusual radiation history to have orginally acquired such high natural TL levels..

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THERMOLUMINESCENCE OF METEORITES FROM THE LEWIS CLIFF: ICE MOVEMENTS, PAIRING, ORBIT, AND ANTARCTIC/NON-ANTARCTIC COMPARISONS. **P.H. Benoit, H. Sears, and D.W.G. Sears.** Cosmochemistry Group, Dept.of Chemistry and Biochemistry, University of Arkansas, Fayetteville AR 72701.

The Lewis Cliff region has been a prolific source of meteorites. To date, with sampling basically completed, approximately 2000 meteorite fragments have been returned from this area (1). We have been engaged in a routine thermoluminescence (TL) survey of these meteorites as part of their initial characterization (2-3). We had noted several interesting features in the data (4) but only recently have we been able to examine the data in detail in the light of field and petrographic observations. We present here data for over 300 meteorites, this subset consisting of larger (>20g) samples which are suitable for this analysis.

The Lewis Cliff site consists of two major geographic divisions, the Lower and Upper ice tongues (LIT and UIT, respectively), and several adjoining sites (Meteorite Moraine and South Lewis Cliff). The Lewis Cliff site is younger than most of the Allan Hills sites and this is reflected in the generally higher natural TL values in the Lewis Cliff samples. Within the Lewis Cliff sites, however, there is evidence that the UIT has meteorites with lower natural TL than the LIT and Meteorite Moraine. This suggests that the UIT consists of older ice relative to the other sites. This difference between the adjoining LIT and UIT is accentuated by the differences in shape and orientation of 27 pairing groups; those of the UIT are strongly oriented N-S while those of the LIT are randomly oriented and are often non-linear. All the icefields have a similar percentage (~15%), after accounting for pairing, of very low natural TL meteorites (<5 krad), which reflects the proportion of meteorites with low perihelion orbits (5).

The induced TL sensitivity of most of the Lewis Cliff samples is significantly lower than those of non-Antarctic falls, a difference which can be attributed largely or wholly to weathering (6). There are, however, differences in induced TL peak temperature-width between sites (Fig. 1) which cannot be explained by weathering. UIT meteorites have a broad range of peak temperatures similar to Allan Hills meteorites (7-8). Meteorites from the LIT and Meteorite Moraine, however, tend to approach the non-Antarctic line.

We suggest that these data show that the ice at the UIT and the LIT is "uncoupled", with the older UIT overriding the LIT and Meteorite Moraine. The older meteorites (from UIT) are similar to those from the Allan Hills while the younger meteorites (LIT and Meteorite Moraine) are more similar to modern non-Antarctic meteorites. This suggests that there are at least two populations of meteorites in the Antarctic: an older group with more varied thermal (non-terrestrial) histories and a younger group with much more homogeneous histories.

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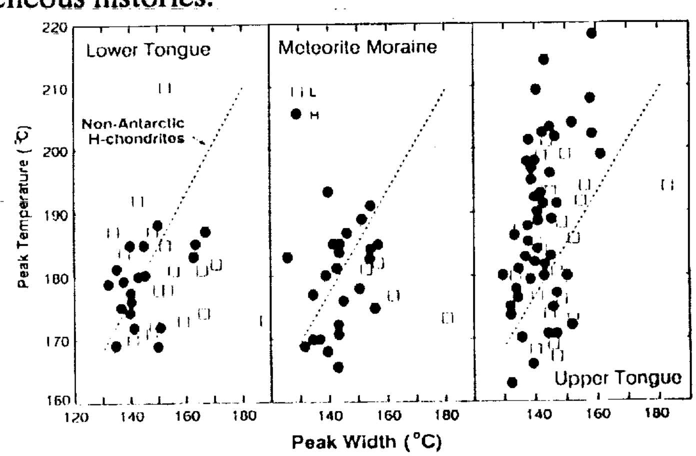

TEM CATHODOLUMINESCENCE SPECTRA OF METEORITIC MINERALS.

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Most cathodoluminescence (CL) studies of minerals have been done using SEMs, electron microprobes, and petrographic microscopes (Luminoscopes). TEM CL measurements have been made on synthetic materials such as semi-conductors. This is one of the first studies of CL of minerals using the TEM. We have been studying selected minerals in the Allende CV3 carbonaceous chondrite, following and extending the research of Steele (6, 7, 8).

We have determined that high-quality TEM CL spectra can be obtained from natural samples. TEM CL spectra are comparable in wavelengths of peaks and relative peak intensities to CL spectra from microprobes and Luminoscopes. Spectra taken at liquid nitrogen temperatures provided new spectral information. In such spectra of Allende forsterite, we found sharp peaks resembling those caused by Cr^{+3} in spinel (see Figure). Measurements of synthetic forsterites (Mg_2SiO_4 and Mg_2SiO_4:Cr^{+3}) support the conclusion that these peaks are caused by Cr^{+3}; however, the relationship between the sharp peaks from the two different minerals is not yet understood. In addition, the question remains as to the cause of the remaining broad band at 800 nm. It may be caused by Cr^{+3}, by another activator ion, or even by structural defects.

Anorthite from Allende CAIs gives a strong broad peak at 420 nm. The blue CL in lunar and terrestrial plagioclase has been related to the blue CL in forsterite and other silicate minerals (1). Blue luminescent intensity in quartz increases 1300 times when cooled to -100°C (3). Preliminary studies show that the blue luminescence in Allende forsterite increases when cooled to liquid nitrogen temperature, whereas the luminescence of anorthite is greatly decreased. This behavior suggests that the activator for blue luminescence in these minerals may not be the same. In fact, synthetic anorthites (2, 4) and synthetic forsterites from our study show no blue CL, while synthetic quartz does (3). This difference makes it questionable to attribute the blue CL to its cause in quartz (1).

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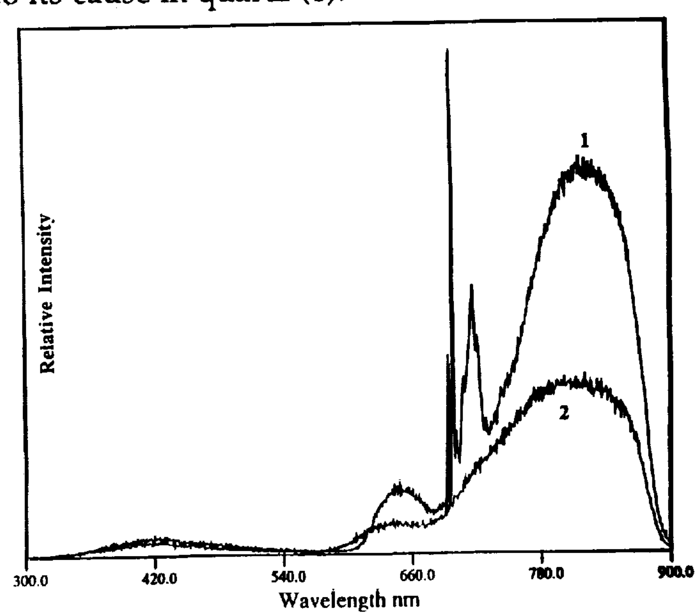

Caption: CL spectra of Allende forsterite at (1) liquid nitrogen temperature (~-170°C) and (2) room temperature. (Spectra are uncorrected for instrumental response.)

DEPTH AND SIZE DEPENDENCE OF COSMOGENIC NUCLIDE PRODUCTION RATES IN METEOROIDS. N. Bhandari[1], K. J. Mathew[1], M. N. Rao[1], U. Herpers[2], K. Bremer[2], S. Vogt[2], W. Wölfli[3], H. J. Hofmann[3], R. Michel[4] and R. Bodemann[4]

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Depth profiles of the cosmogenic isotopes ^{3}He, ^{21}Ne, ^{22}Ne, ^{10}Be and ^{26}Al have been measured in three chondrites: Madhipura, Udaipur and Bansur. Samples from known depths from the meteorite cores were chemically processed for Al and Be for measurement of ^{10}Be and ^{26}Al by accelerator mass spectrometry at Zürich [1].Track density and rare gas measurements were made at PRL. ^{53}Mn was measured in several fragments of Dhajala. ^{21}Ne exposure ages were calculated following Eugster [2]. Shielding depths of the samples and meteoroid sizes were derived from track density and the ^{21}Ne exposure ages.

The above data, together with ^{53}Mn profiles in these meteorites and depth profiles of several cosmogenic radionuclides, rare gas isotopes and tracks in ALHA 78084, Keyes, St. Severin, Knyahinya and Jilin, available in literature, provide an experimental data base describing the depth and size dependence of cosmogenic nuclides in chondrites for preatmospheric radii in the range of 8 to ~100 cm.

Production rates are found to change only slightly with depth in small meteoroids ($R \leq 15$ cm). For larger bodies ($15 < R < 30$ cm) the profiles show significant depth dependence increasing from surface to center by about 30%. The center production rates increase with meteoroid size and show a broad maxima for radii between 25 and 45 cm. The location of the maxima depend on whether the nuclides are predominantly produced from their target elements by high or low energy particles. For radii above ~ 70 cm a significant decrease of center production rates is seen for ^{10}Be, ^{26}Al and ^{21}Ne.

The observed depth profiles and the dependence of the center production rates on meteoroid size are well reproduced by model calculations based on Monte Carlo techniques using the HERMES code system [3,4,5]. The model calculations thus provide a basis for identification of meteorites having anomalous level of radioisotopes and give information about the irradiation history of meteorites and changes in the cosmic ray intensity with time or in orbital space of the meteoroid.

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THE RHENIUM OSMIUM CHRONOMETER : THE IRON METEORITES REVISITED.

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The ^{187}Re - ^{187}Os decay scheme has potentially a wide spread application in the field of geochronology. Its principal interest over the other common chronometers stands in the siderophilic nature of both elements. Its use has been limited by a number of setbacks : the level of Re and Os in natural samples is very low : generally in the sub ppb range ; due to its high ionization potential and to its refractory nature, Os has been very difficult to ionize in mass spectrometers.

The recent development of negative thermal ionization of volatile oxides (3,6) circumvents the ionization problem providing both very high sensitivy and the precision of thermal ionization mass spectrometers.

We present here some new-data making use of this technique. The Re-Os chronometer is particularly well suited for meteorites and is so far the only tool for dating directly the metal phase of iron meteorites. Among the iron meteorites, some have inclusions which have been already investigated with more traditional chronometers : K - Ar, Rb-Sr, U-Th-Pb. The inclusions of Kodaikanal have been reset for both Rb-Sr and U-Pb at 3,7 By. The purpose of this work is to investigate the metal phase itself in the hope to constrain more precisely the resetting event.

Our Re-Os experimental technique is close to those already published for the mass spectrometry (3,6). A new chemical separation method has been developed to better fit typical clean lab procedures.

Results : Os sample sizes of 5 to 10 ng provided typical precisions of 5 ε unit (10^{-4} in relative deviation) on the $^{187}Os/^{186}Os$ ratio. Ionization yields are comparable to other labs with the same method (3).

For this study, aliquots of 2 à 5 mg of iron meteorite have been used. Our measurement on Canyon Diablo is within analytical errors of previous ion probe data Kodaikanal shows a $^{187}Os/^{186}Os$ in the low end of iron meteorites close the IIIAs and the mesosiderite Estherville. Mineral separates and Re-Os concentrations are under investigation.

Sample	187Os/186Os	Error
Lab Standard	1.4455	0.0006
Canyon Diablo	1.1262	0.0009
Kodaikanal	1.0679	0.0007

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NEW CARBONACEOUS AND TYPE 3 ORDINARY CHONDRITES FROM THE SAHARA DESERT.
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From a total of about 300 new meteorite samples recovered from different locations in the Sahara desert in 1989, 1990, and 1991 (compare Meteoritical Bulletin No. 71, 1991), about 100 meteorites have been classified so far. Among these samples 12 type 3 ordinary chondrites (9 H3, 2 L3, 1 LL3) exist probably from 9 different falls. Three of the H3-chondrites are interesting chondritic breccias containing abundant H4-6 clasts. The LL3-chondrite Adrar-003 appears to be one of the most unequilibrated ordinary chondrites ever found. Among the other ordinary chondrites several spectacular chondritic breccias exist containing for example the rare phases ringwoodite and maskelynite (Acfer-040,-072, Hamada El Hamra-007). Besides two mesosiderites and one type IIIAB iron meteorite (Plateau du Tademait-002; Ni: 10.30 wt.%, Ga: 18 ppm, Ge: 33 ppm) a very interesting enstatite-rich meteorite exists that could be characterized as a metal-rich achondrite (Ilafegh-009).

The collection of Sahara meteorites contains a high proportion of carbonaceous chondrites. So far, 14 carbonaceous chondrites were identified resulting from at least five distinct falls (Table 1). Eight samples - CR-like chondrites (Acfer-059,-087,-097,-114,-139,-186,-187,-209) - were found within an area of approximately 45 x 12 km. A ninth CR-like sample (El Djouf-001) mineralogically very similar to and probably paired with the other eight meteorites (1) was found >500 km SW of the Acfer region. Acfer-097 has similar contents of Zn (60 ppm) and Se (4.68 ppm) to Renazzo; the refractory elements are enriched relative to CI by a factor of $\approx$1.4. Two CV-chondrites (Acfer-082, Acfer-086) were identified. Their refractory elements Sc, REE, Hf etc. are enriched relative to CI by a factor of $\approx$1.6. The sample Acfer-086 is contaminated by terrestrial products resulting in high Ca- and Sr-contents and the presence of abundant calcite. CAIs within Acfer-086 have a greenish appearance in thin section. Acfer-094 has trace element characteristics of CM-chondrites (Fe/Mn: 123; Se: 14.9 ppm; Zn: 205 ppm), but cannot be a CM-chondrite based on the oxygen isotopic composition (Table 1). Mineralogically, it appears to be a CO-chondrite. The samples Acfer-182 and -207 belong to a "unique" chondrite that clearly can be distinguished from the major chondritic groups by the peculiar mineralogical and chemical properties. They are similar to the anomalous chondritic breccia ALH85085 (2), but not identical. The Fe-content of 34.56 wt% is high like that of ALH 85085 (39.8 wt.%; (2)), and higher than in other carbonaceous chondrites. Like in ALH85085 the moderately volatile elements Na, K, Mn, Se, and Zn are depleted relative to CI by factors between 0.098 and 0.5. The refractory siderophile elements W, Re, Os, Ir, and Pt are enriched by a factor of $\approx$2 relative to CI.

Table 1: Oxygen isotopes

Sample	$\delta^{18}O$	$\delta^{17}O$	Class
Acfer-082	1.53	-2.93	CV3
Acfer-086	3.71	-1.48	CV3
Acfer-094	1.11	-3.91	CO/CM
Acfer-097	2.10	-1.53	CR
Acfer-182			unique
Ilafegh-013	3.68	2.66	H3

(1) Weber H.W. and Schultz L. (1991), this volume. (2) Bischoff A. et al. (1989), LPS XX, 80-81.

MID-IR SPECTROSCOPY OF ANTARCTIC CONSORTIUM METEORITES: B-7904, Y-82162 and Y-86720

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Diffuse reflectance of the Antarctic Consortium meteorites Yamato (Y)-86720, Yamato (Y)-82162 and Belgica (B)-7904 has been measured from 1-25 µm. Visible and near-infared reflectance spectra of these meteorites and the implications of their physical and spectral properties are discussed in a companion abstract (1). Descriptions of the petrology and chemistry of these samples are provided by (2,3). Spectra were measured using a Nicolet 740 FTIR in a purged (water and CO_2 free) environment. B-7904 and Y-86720 were examined both as chips and as powders with particle size <125 µm. Y-82162 was examined in the chip form only due to a surface coating. Independent measurements were made with KBr and gold as standards.

Mid-IR spectra of B-7904, Y-82162 and Y-86720 against KBr from 2 - 24 µm are shown below (variable wavelength scale). Each of the meteorite samples examined shows water absorptions at 3 µm (3450 cm^{-1}) and 6 µm (1640 cm^{-1}). The weak, sharp band at 4.3 µm (2350 cm^{-1}) is due to minor variations in the CO_2 level in the sample chamber. B-7904 and Y-86720 powders exhibit mineral and hydrous features comparable to those reported by (4, 5, 6). The strength of the reststrahlen bands near 11 µm is greatly enhanced in the spectra of the chip samples relative to the spectra of the particulate samples. The Y-82162 chip exhibits significantly stronger water absorptions at 3 µm (3450 cm^{-1}) and 6 µm (1640 cm^{-1}) than the others. The 6 µm feature appears to be anomalously strong, suggesting that more that one species may be contributing to the absorption. The spectrum of Y-82162 also shows a strong feature at 6.8 µm (1470 cm^{-1}) which has been attributed to carbonates by (7, 6, 5) and CO_3^{2-} by (8). Both the particulate and chip spectra of B-7904 and Y-86720 include weak absorption features at 7.4 µm (1350 cm^{-1}). This feature has been observed in all Antarctic meteorites measured in the Mid-IR and has been assigned to hydrous carbonates formed by terrestrial weathering (9 & ref. therein).

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