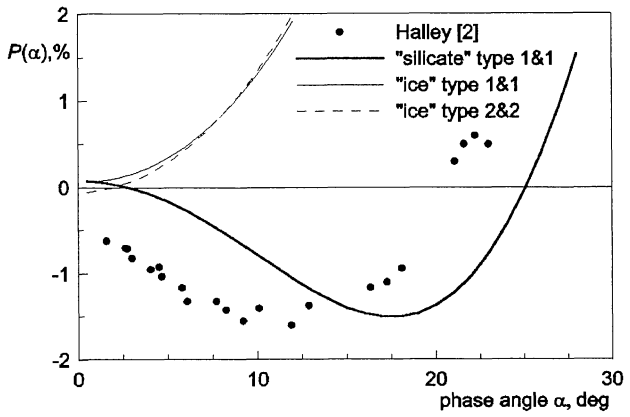

Fig. 1.

composed by 2 seeds of material and 2 seeds of space (type 2&2). For examples, similarly generated particles cross-sections see [5].

Result and Discussion: Our simulation before size averaging show that "ice" random particles, unlike spheres, do not produce negative polarization on equivalent size parameter $x_{eq} = 0.5 \div 3.5$. "Silicate" random particles do give the negative polarization branch, but it is very undulated.

The size averaging essentially smoothes these undulations of the phase dependencies of linear polarization degree $P(\alpha)$ (see Fig. 1). As it was expected, the averaging of "ice" random particles does not produce the negative polarization anywhere. At $u = 2.3$ the averaging for "silicate" random particles gives the negative branch at small phase angle. In this case, the minimal value of P and inversion angle both are close to observed ones [2]. The shape of the calculated negative polarization branch differs from observational data. This can be corrected with taking into account of a possible contribution of large particles ($x_{eq} > 10$).

Note, that $P(\alpha)$ weakly depends on structure of a single scatterer: curves corresponding to particles of type 1&1 are similar to curves for particles of type 2&2.

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MINERALOGY AND PETROGRAPHY OF THE L6 CHONDRITE RIO DO PIRES, BRAZIL. M. E. Zucolotto[1] and L. L. Antonello[1], Departamento de Geologia e Paleontologia - Museu Nacional/UFRJ – RJ, Brazil (zucolotto@acd.ufrj.br).

Introduction: A single stone meteoritic mass, of 118 g, almost entirely covered by fusion crust, was found by a student of Prof. H. Shigame from Universidade Federal da Bahia; near the city of Rio do Pires (13°07.40'S, 42°17.31'W). It was then donated to Mr. W. Carvalho. A slice weighing 12 g was permuted with Museu Nacional of Rio de Janeiro. The meteorite was registered and classified by Brearley in Met. Bull 77 [1]. No description of this meteorite was published so far.

Materials and Methods: The following notes on mineralogy and texture are based on the study of four polished thin section, the samples were studied optically by transmitted and reflected light and electronically by SEM/EDS and EPMA.

Results: A broken sample shows a light gray color and fine matrix with few visible chondrules, shock veins and few patches with areas of brown color and metal points. The crust is black with an average thickness of 0.3 mm and covers almost completely the external surface.

It displays poorly defined chondritic textures. Most of the chondrules are broken and appear as fragments; only very, few display well-defined rounded or elongate shapes. Appear as fragments ranging from 0.3 to 5 mm in diameter. The opaque minerals occur as interstitial and as inclusion in the chondrules.

Mineralogically it consists of essential olivine $Fa_{25.53}$, pyroxene $Fs_{21.85}En_{76.7}W_{1.45}$, kamacite with 0.8% Co, plessite, taenite and troilite; accessory plagioclase $Ab_{58.52}An_{25.18}Or_{16.30}$, daubrèelite, chromite and maskelynite; secondary hematite and goethite and/or lepidocrosite. Pyroxene, olivine, plagioclase and opaque minerals exhibit shock features as undulatory extinction and fractures.

The matrix shows highly recrystallized, with uniform crystalline material composed of olivine, pyroxene, opaque minerals, clear interstitial grains of plagioclase, maskelynite, secondary hematite, goethite and/or lepidocrosite.

The chondrules are poorly defined and present considerably variations in their internal texture; the majority is characterized as granular olivine-pyroxene, porphyritic olivine-pyroxene and radial pyroxene.

Polished sections etched by nital 2%, show opaque phases composed of: zoned taenite grains with an outer rim of 1–10 μm of tetrataenite followed by cloudy taenite and the interior is formed by martensite or, fine grained plessitic or a combination of both. Some well-defined plessite grains are also present; kamacite is common with Neumann bands or in sometimes recrystallized.

Troilite occurs as isolated grains or in contact with kamacite or taenite. Under quite crossed polars it appears that all grains in the same field have the same anisotropic extinction. Only very few large troilite nodules exhibits a slight mosaicism. The presence of melt pockets is also common.

Discussion: Based on the composition of its constituent minerals and chemical data, particularly of olivine $Fa_{25.5}$ and Co 0.8% in kamacite and pyroxene $Fs_{21.8}$, it belongs to the L-group. By the textural features in special homogeneity of kamacite and the presence of poorly defined chondrules, it was classified as petrologic type 6. According to the shock nomenclature for ordinary chondrites [2], it was previously classified as S6 [1]. Although the absence of planar deformation features, the presence of plane fractures and undulatory extinction in olivine, the presence of maskelynite and plagioclase in the sample are characteristic of shock stage < S5. As proposed by [3] the opaque phases such as FeNi metal and troilite should also shock classify chondrites. In Rio do Pires, troilite with only slight mosaicism, the presence of martensite, Neumann at kamacite and undisturbed taenite indicate a shock stage ≤ S4 and lead to the conclusion that the Rio do Pires has a shock stages S3 or S4 instead of S6.

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A METALLOGRAPHIC AND EBSD STUDY OF THE MARIA DA FÉ IRON. M. E. Zucolotto[1] and A. L. Pinto[2], [1]Museu Nacional/UFRJ, Quinta da Boa Vista, Rio de Janeiro 20940-040, Brazil (zucoloto@ism.com.br), [2]IME —Instituto Militar de Engenharia (pinto@ime.eb.br).

This Iron meteorite was found around 1987, at the city of Maria da Fé (20°.30S; 45°.37W) at vicinities of Itajubá, Minas Gerais State, Brazil. Many masses were found during the cleaning of the Eucalyptus forest for potato cultivation when the plough's blades began to break. Unfortunately only one mass was preserved which was given to the owner's son Diógenes B. Ninis, who keep it as a curiosity until 1999, when he informed the LNA (Laboratório Nacional de Astrofísica) and a sample was sent to Museu Nacional for identification.

The mass measures (26 x 14 x 12 cm.) and weighs 18 kg. It is weathered and covered with 0.5 – 1 mm thick crust of terrestrial oxides no fusion crust is preserved.

Polished and etched (2% nital) sections showed that the heat affected α_2 zones have been removed by corrosion and weathering products penetrate into the interior. All sections displayed fine and homogeneous widmanstätten structure, which presented kamacite lamellae with 0.35 ± 0.05 mm width of straight long (L/W ~20). The kamacite bands exhibited profuse Neumann lines, varying in quantity from grain to grain. They are commonly crossing three or more kamacite lamellae at the same direction, sometimes also crossing plessite fields. The kamacite was shock-hardened to a micro hardness of HV 240 ± 15 and displayed some mate hatched ε structure suggesting shock intensity above 130 kbar.

Taenite and plessite covered about 30% of the observed area, mostly as net black and duplex plessite, some poorly resolvable. Cellular and

(olivines and pyroxenes), and on only those instances in which some of the reactant silicate remains, direct compositional relationships between reactants and products, and the elemental mobility required by the reactions, can be established.

Results: *Nogoya.* Olivine compositions ranging from Fo_{65} to Fo_{99} were observed in Nogoya [6], as is common in CM chondrites in general and as previously reported for Nogoya. Serpentine meshworks across, and replacement rims on, olivine have a narrow range of Fe/(Fe + Mg) (molar) ratios, around 0.20 ± 0.02 (Fe corrected for the presence of finely disseminated sulfides), regardless of the composition of the reactant olivine [6]. Stoichiometric replacement reactions were written based on the assumption of constant solid volume before and after reaction. Formation of serpentine of the observed uniform alteromorph composition from olivine that is more forsteritic than Fo_{88} required importation of Fe (in excess of the amount required to form finely disseminated sulfides). Formation of serpentine of the same composition from olivine that is more fayalitic than Fo88 released excess Fe, which was either exported or taken up as discrete sulfides [6].

Comparison with ALH 81002. In ALH 81002, all silicate-replacement serpentines (including those formed from compositionally diverse olivines, orthopyroxene, clinoenstatite, and augite) are uniformly Mg/(Fe + Mg) = ~0.50–0.55 (wt%), regardless of the reactant mineral, but different from serpentine replacing glass Mg/(Fe + Mg) = ~0.3 (wt%) [7]. ALH 81002 replacement serpentines are significantly more Fe-rich (Fe/(Fe + Mg) (molar) ~0.3) than those in Nogoya.

Implications: (1) Importation of Fe is required in some pseudo/alteromorphs in the two CM chondrites, and Fe exportation is required in others, suggesting that secondary-mineral composition depended little on elements supplied locally by the reactant mineral and more strongly on external factors such as solution composition. (2) Intrameteorite homogeneity of replacement serpentine exists in each CM chondrite, regardless of the composition of the reactant olivine. This strongly suggests that the aqueous medium driving the replacement reaction was compositionally uniform on scales much larger than individual olivine crystals, chondrules, or clasts in each CM meteoroid. (3) Intermeteorite heterogeneity of both replacement [6,7] and chondrule-rim and matrix [2,4] serpentine compositions between different CM chondrites implies larger-than-meteoroid heterogeneity of the CM aqueous alteration environment. One consequence is that different CM chondrites have *different* threshold olivine compositions for the transition from Fe-importer to Fe-exporter. It remains to be established whether larger-than-meteorite-scale heterogeneity in the alteration environment was due to different CM chondrites sampling (a) different spatial regions of a large spatially heterogeneous alteration environment, (b) a single temporally evolving aqueous alteration system at different stages of its chemical evolution, or (c) different discrete and isolated aqueous alteration environments.

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C, N AND NOBLE GASES IN DIFFERENT pH AND GRAIN SIZE FRACTIONS OF PRE-SOLAR DIAMONDS FROM BORISKINO CHONDRITE.

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Introduction: Recently it has been shown that pre-solar diamonds extracted from meteorites can be separated into grain-size fractions by means of ultracentrifugation [1,2]. It transpires that grains of different sizes have distinct carbon, nitrogen and noble gas isotope signatures. In addition, noble gas concentrations vary by orders of magnitude [3], which has been explained by ion implantation [4]. We believe that grain-size analysis offers the best hope of understanding the nature of the isotopically and genetically different components acquired by diamonds during their irradiation history. It is already well established that the behavior of nanometre diamonds in solution (and during ultracentrifugation, in particular) is determined by their charge, which depends on the number of acid groups on their surfaces [5]. To investigate whether parameters such as particle grain size and/or number of defects on their surfaces are affected by solution chemistry, we have extended the grain-size separation technique to combine ultracentrifugation with colloidal separations at different pH.

Experimental: The starting material was a diamond colloid isolated from Boriskino (CM2). This diamond was centrifuged (700 g, 6 h) at pH~3 to produce a supernatant (designated as BD-1) and a sediment. The sediment was then transferred into solution at pH~3.8 and centrifuged (700 g, 6 h) to produce two further fractions (supernatant BD-2) and sediment. The sediment was repeatedly centrifuged (700 g, 6 h) at p? > 5 to produce supernatant (fraction BD-3) and another sediment. Each fraction was then put into solution at pH>5 and ultracentrifuged simultaneously (10^5 g for 4 h) to produce samples of sediment and supernatant (designated a and b). These were then analysed by MS-86 [6] for carbon isotopes and Finesse [7] for C, N and noble gases. Herein we present the results for BD-1a, BD-1b, BD-3a and BD-3b.

Results: As in previous studies [1,2] grain-size fractions a/b for BD-1 and BD-3 showed differences in concentrations and isotopic compositions of all elements analysed. However, we also observed smaller but significant differences between BD-1 and BD-3 (Fig. 1). For some parameters ([Ar], [Xe] and Xe isotopes) these differences are in keeping with the variations observed between a and b which suggests that pH separation is sensitive to grain sizes. In contrast, variations in nitrogen isotopes and [^{4}He] between BD-1 and BD-3 are at odds with simple grain size separation. It seems that other properties, such as the presence of defects, for instance, might play a role during pH separation, indicating that these diamonds could represent a different population. In particular, the data in the Figure indicate that in addition to two major diamond populations—(i) the carrier of Xe-HL with relatively heavy carbon isotopic composition ($\delta^{13}C > -25‰$) and (ii) the carrier of Xe-P3 with light carbon ($\delta^{13}C < -41‰$)—a third population might be present, possibly the carrier of Xe-P6, with an intermediate $\delta^{13}C$.

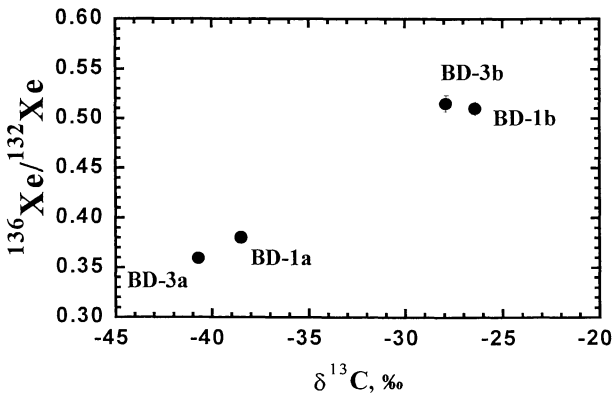

Fig. 1.

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ATTEMPS TO SEPARATE THE Q-NOBLE GAS CARRIER IN YILMIA.

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Introduction: Recently we have shown [1] that the planetary noble gas carrier (Q-phase [2]) is a distinct physical substance which can be

THREE-DIMENSIONAL MICROSTRUCTURES OF ANTARCTIC MICROMETEORITES BY X-RAY COMPUTED MICRO-TOMOGRAPY USING SYNCHROTRON RADIATION AT SPRING-8. A. Tsuchiyama[1], K. Uesugi[2], T. Noguchi[3], H. Yano[4], T. Nakano[5], and Y. Suzuki[2], [1]Department of Earth and Space Science, Osaka University, Toyonaka 560-0043, Japan (akira@ess.sci.osaka-u.ac.jp), [2]Japan Synchrotron Radiation Research Institute, Mikaduki 679-5198, Japan, [3]Department of Material Sciences and Biological Sciences, Ibaraki University, Mito 310, Japan, [4]Institute of Space and Astronautical Science, Sagamihara 229-8510, Japan, [5]Geological Survey of Japan/NIAIST, Tsukuba 305-3651, Japan.

Introduction: X-ray CT is a non-destructive method for investigation of materials by using X-ray attenuation. 3-D internal structures can be obtained by constructing a number of successive cross-sectional CT images. Lately, an X-ray computed microtomographic system using synchrotron radiation has been developed at SPring-8 in Japan, which can give spatial resolution of about 1 μm [1]. As monochromatic X-ray beams are used in this system, we may obtain information of elemental distribution by using X-ray adsorption edge of the element. We have applied this system to Antarctic micrometeorites (AMMs).

Experiments: Four AMMs (Y98M03KS036, 068, 074 and 094) [2] were imaged at BL47XU in SPring-8. We selected large samples (about 100 μm) from the AMM catalogue [3]: one of them (KS074) looks unmelted and seems to include coarse-grained crystals and the other three are vesiclated to scoriaceous. The photon energy was 10 keV. For one sample (KS094) imaging at photon energies just below and above the Fe-K edge (7.112 keV) was also made to obtain Fe distribution images. Cross-sectional CT images are reconstructed by a convolution back projection method. It took about a few hours for imaging and 5–10 hours for reconstructing about 200 CT images for each 3-D structure.

Results and Discussion: "Coarse-grained crystals" in KS074 were imaged as grains of about 10 μm. Based on the CT-values, these grains must be olivine or pyroxene with rims rich-in FeO. The most vesiclated sample was KS068. Many vesicles are not connected to the outside three-dimensionally. Only small amounts of vesicles were observed in the samples, KS036 and KS094. Structures, which look like Fe-rich rims, were also observed although we cannot exclude a possibility that the structures are artifacts due to refraction of X-ray by the samples. The whole surface of KS068 is covered by this structure, while the surfaces of KS036, 074 and 094 are partially covered.

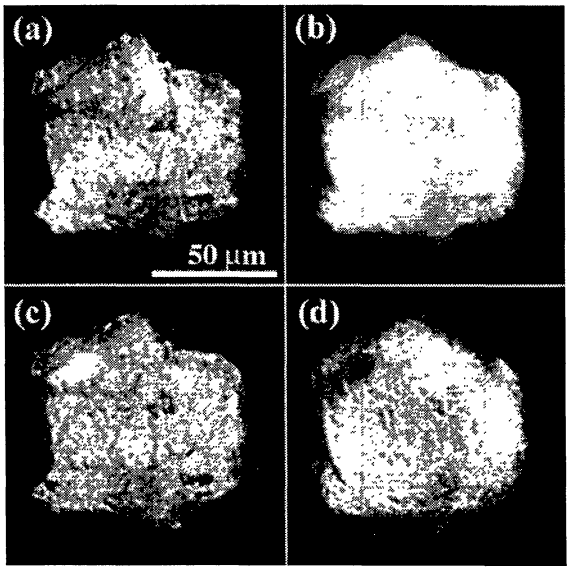

Fig. 1. CT images of the same slice of AMM, Y98M03KS094. (a) 10 keV. (b) 7.115 keV. (c) 7.105 keV. (d) Fe-K image. The gray scales are arbitrary. 0.5 μm x 0.5 μm pixel.

Examples of CT images of KS094 are shown in Fig. 1. Fe images were obtained by subtracting the 7.105 keV images from the 7.115 keV images (Fig. 1d). We can recognize Fe-poor grains, which are not seen in the 10 keV images. Heterogeneous distribution of Fe, which may reflect original Fe distribution more or less modified by heating during entrance into the Earth's atmosphere, is also seen.

This is the first study, in which 3-D microstructures of AMM were obtained with sufficient spatial resolution. Furthermore, we succeeded in obtaining 3-D structure of Fe, which is one of the most important elements in planetary samples, for the first time. The present microtomographic system is suitable for Fe-K imaging with sufficient spatial resolution due to the low Fe-K edge energy. The present results strongly showed that the method is useful for studying micrometeorites and probably some IDPs.

Acknowledgements: The AMM samples were collected by the 39th JARE team in 1998 and kindly supplied by NIPR.

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NITROGEN MICRO-ANALYSIS OF GLASS INCLUSIONS IN CHONDRITIC OLIVINES BY NUCLEAR REACTION. M. E. Varela[1], M. Bonnin-Mosbah[2], and G. Kurat[3], [1]CONICET-UNS, Dpto de Geologia, San Juan 670, 8000, B. Blanca, Argentina (evarela@criba.edu.ar), [2]Laboratoire Pierre Süe, CEA-CNRS, Saclay, 91191, Gif sur Yvette, France, [3]Naturhistorisches Museum, Postfach 417 A1014, Vienna, Austria.

Introduction: New results on nitrogen contents in glasses of glass inclusions, in addition to those already presented [1–3], allow as to speculate on the possible nature of the N species stored in glasses. The nitrogen measurements in glass inclusions were carried out utilizing the $^{14}N(d,p)^{15}N$ reaction (LPS, Saclay, France) [3].

Samples: Nitrogen content in glass inclusions in olivines have been measured in the following chondritic meteorites: *Carbonaceous chondrites:* CV3: Allende DI, (PTS, 4884-2B, AMNH, New York); Ningqiang, (PTS, no number, NM, Vienna); CO3: Dar al Gani 083, 291, 289, 005 (PTS all from NM, Vienna). CR: Renazzo (PTS L3428, NM, Vienna), Acfer 128 (PTS, NM, Vienna); El Djouf 001 (PTS AMNH, New York); C4: Hammadah al Hamra 073 (PTS NM, Vienna); CH3: Acfer 214 (PTS NM, Vienna).

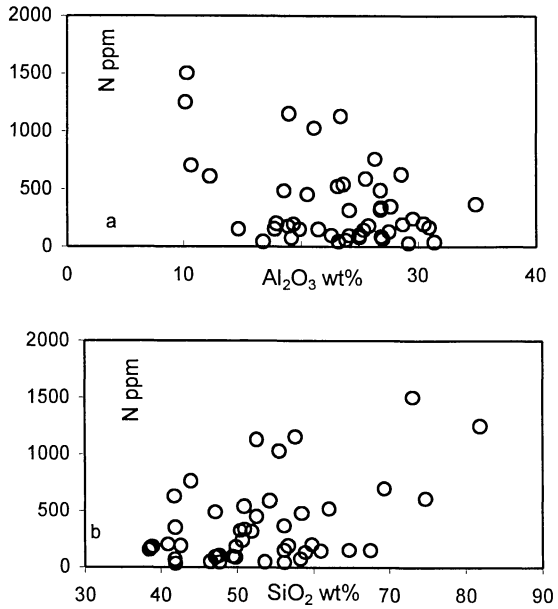

Fig. 1. Variation of Al_2O_3 and SiO_2 vs. N contents in glasses of glass inclusions in chondritic olivines.

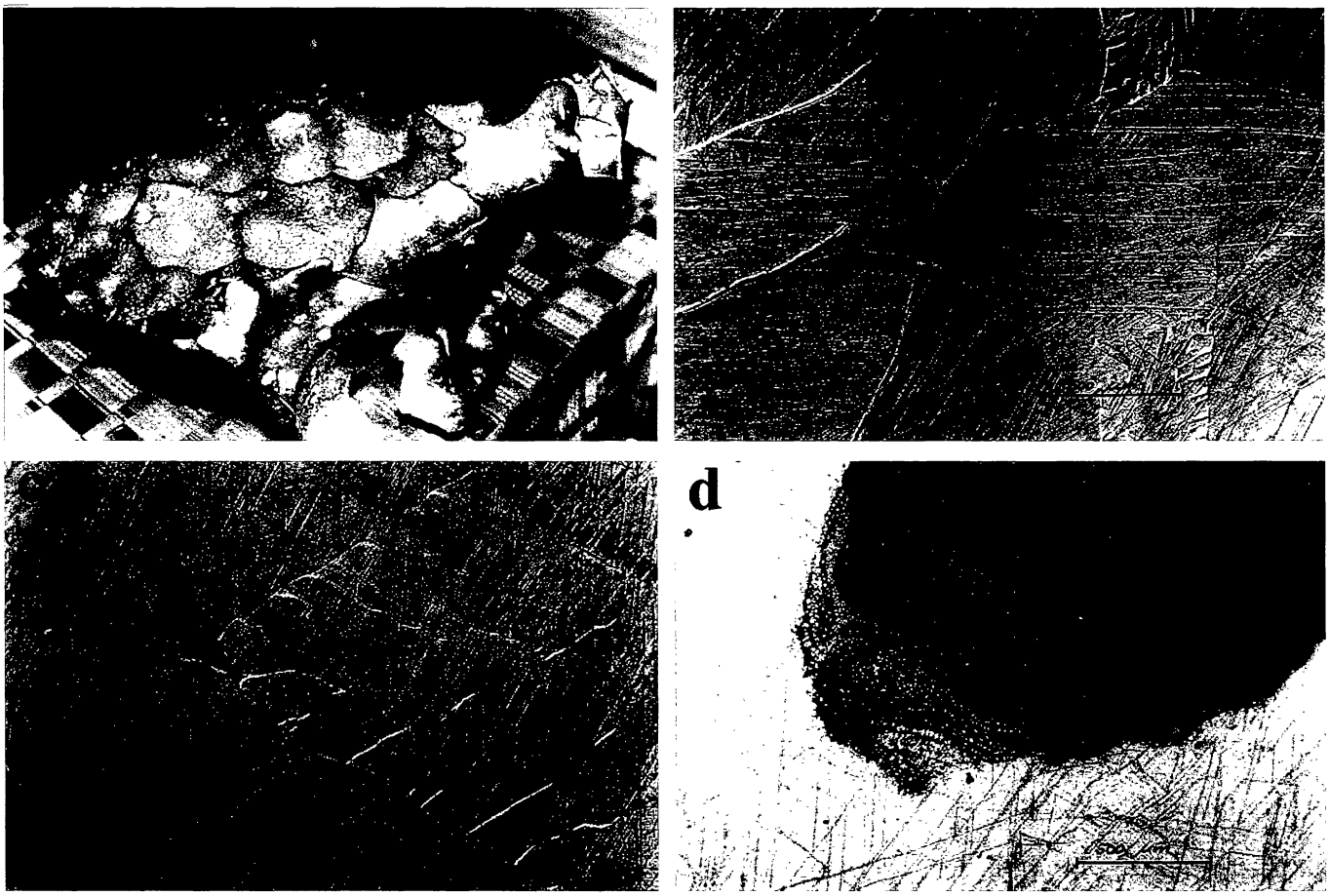

Fig. 1. (a) Alatage meteorite, Changchun Mining School. (b) Kamacite with bent Neumann lines and martensitic plessite fields (bar = 500 μm). (c) Degenerated comb plessite field (bar = 500 μm). (d) Troilite-daubreelite nodule with iron-troilite eutectic and cubic cleavage (bar = 500 μm).

The observed faces show two troilite nodules of 3 × 2 and 1.5 × 1.5 mm^2 containing daubreelite grains up to 10 μm. The nodules are surrounded by iron-troilite eutectics (Fig. 1d).

Daubreelite was observed as discrete grains up to 200 μm in kamacite, too.

The Alatage metallography reflects complex stress-strain conditions with shock waves of ~100 kPa (Neumann lines, cubic cleavage, shock-melted troilite) and subsequent cosmic reheating (decorated Neumann lines), followed by a moderate collision (bent Neumann lines) (Buchwald, 1975; Bischoff and Stöffler, 1992).

Structurally this meteorite resembles a medium octahedrite of chemical group IIIAB. The chemical group IIIA classification of Alatage is also confirmed by INAA investigation (Table 1).

Acknowledgments–We are grateful to Feng Tong Zhao (Changchun Mining School) for donating the Alatage sample (Changchun, 1991) and to Teves-Continental (Gifhorn) for making available the microscope equipment. Furthermore we thank Allan Rubin (University of California, Los Angeles) and Joseph Goldstein (University of Massachusetts, Amherst) for their most helpful reviews and critical comments.

TABLE 1. INAA results.

Element	Concentrations	Error
Fe	90.5%	3%
Ni	7.89%	5%
Co	0.4703%	3%
Na	1.90 ppm	3%
Cl	10.0 ppm	20%
K	<2 ppm	–
Cr	92.0 ppm	15%
Cu	162.0 ppm	4%
Ga	18.2 ppm	3%
Ge	34.0 ppm	20%
As	3.64 ppm	3%
Se	<4 ppm	–
Mo	8.40 ppm	10%
Ru	13.0 ppm	20%
Pd	2.40 ppm	7%
Sb	0.060 ppm	25%
W	1.63 ppm	4%
Re	1.11 ppm	4%
Os	14.0 ppm	4%
Ir	11.33 ppm	3%
Pt	14.8 ppm	5%
Au	0.506 ppm	3%

Editorial handling: J. I. Goldstein

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