UNUSUAL COSMIC GRAINS IN A JURASSIC HARDGROUND C. Jéhanno (1), D. Boclet (2), P. Bonté (1), A. Castellarin (3), R. Rocchia (2). (1) Centre des Faibles Radioactivités, Laboratoire mixte CEA-CNRS, 91190 Gif sur Yvette, France. (2) Service d'Astrophysique, CEN-Saclay, 91191 Gif sur Yvette, France (3) Istituto di Geologia e Paleontologia dell'Universita, Bologna, Italia.

The finding of an iridium enriched horizon in a Jurassic sequence of the Southern Alps has been reported lately (1). This horizon, about 180 My old, is located on top of upper Lias, and below Bajocian-Bathonian sediments. The most iridium-enriched (2-3 ppb) basal layer, a few millimeters thick, has been carefully analysed for the identification of the iridium carrier. Numerous small bodies have been easily separated with a magnet. Compositional analysis (neutron activation and X-ray energy spectrometry with an EDS-SEM unit) and optical and SEM observations of external and internal structures reveal the existence of two very distinct populations:

- Population 1, consists of black, nearly perfectly spherical bodies containing on the average 5 ppm of iridium. By their size, external surface features and Ir, Fe, Co, Ni and Cr content they can be unambiguously identified as ancient Fe-Ni cosmic spherules. Like in modern ones their iridium is concentrated in platinoid-rich nuggets or in a nickel-rich core (2) (see fig.1). This population represents a minute fraction of the magnetic bodies and is identical to spherules found by Castellarin et al., (3), Del Monte et al., (4) and Czajkowski et al., (5) in various hardgrounds of the Southern Alps.

- Population 2, is by far the most abundant and the most unusual one. This population exhibits a wide variety of shapes ranging from nearly spherical objects to very irregular rounded pi'ces with globular outgrowths (fig.2) suggesting the coalescence of several melted globules and/or the partial melting of sharp-cornered fragments. The iridium concentration is about 300 ppb, a value representative of a poorly differenciated cosmic parent body. The volume distribution of trace elements, determined by a gradual polishing of irradiated samples (6), shows that Fe, Co, Ni, Cr, Sc and Ir are systematically uniformly dispersed unlike in chondritic or Fe-Ni spherules (6). SEM observations show a wide abundance of magnetic crystals rich in Ni and Cr, distributed in iron oxides, clays and calcite partly resulting from the alteration and replacement of the original silicate matrix. On the external surface these magnetite crystals form a nearly continuous mosaïc-like shell (fig.3). The abundance diagram (fig.4) (normalized to the CI Orgueil carbonaceous chondrite meteorite) of Fe, Ir, Co, Ni and Cr is close to the distribution observed in usual chondritic spherules (6). Essentially contained in the magnetic phase, Fe and Cr are well preserved, but Co is a bit depleted because of matrix alteration. These features suggest that population 2 is composed of chondritic pieces which have been strongly heated and at least partially melted but at a temperature not sufficient to form platinoïd nuggets like those observed in most of modern chondritic spherules (6).

DISCUSSION.

Population 1. The presence of old Fe-Ni spheres is easily explained by the extremely low sedimentation rate responsible for the formation of the hardground. A drop in the sedimentation rate results in the accumulation of the usual cosmic dust accreted by the Earth during a long period which, in the present case, could have lasted a significant fraction of the Toarcian-Aalenian (1). This explanation is consistent with the presence of Fe-Ni spherules in all the hardgrounds of the Southern Alps region analysed so far (3, 4, 5).

Population 2. The presence of this population is surprising as far as its origin and conservation are concerned.

Origin: The high iridium concentration and the abundance of magnetite rich in Ni and Cr clearly indicate a cosmic origin and exclude a strong dilution with a terrestrial component. The coalescence of several globules illustrated by the ordinary morphology of population 2 (fig.2) implies a high concentration of melted grains. This situation never occurs during the accretion of normal cosmic dust grains but is probably usually produced by big meteorite impacts. Hence, we suggest that population 2 is the relict of such an exceptional event which occured during the low sedimentation period encompassed by the hardground.

Conservation: According to Kyte (8) silicate rich cosmic spherules are, unlike Fe-Ni spherules, very rapidly altered in marine sediments. Thus, chondritic spherules deposited during the Jurassic times have been completely dissolved. In contrast, population 2, whose original

compositional characteristics should have been close to chondrite, has been beautifully preserved for 180 My! The reason for that exceptional resistance is not understood. Tentatively we suggest that it could be due to a particularly resistive matrix or, more likely, to the existence of a magnetite-rich shell which, upon handling, appears to be a rather stiff structure.

In the absence of any definite explanation we can however conclude that at least two sources are responsible for the iridium anomaly observed in the Jurassic hardground.

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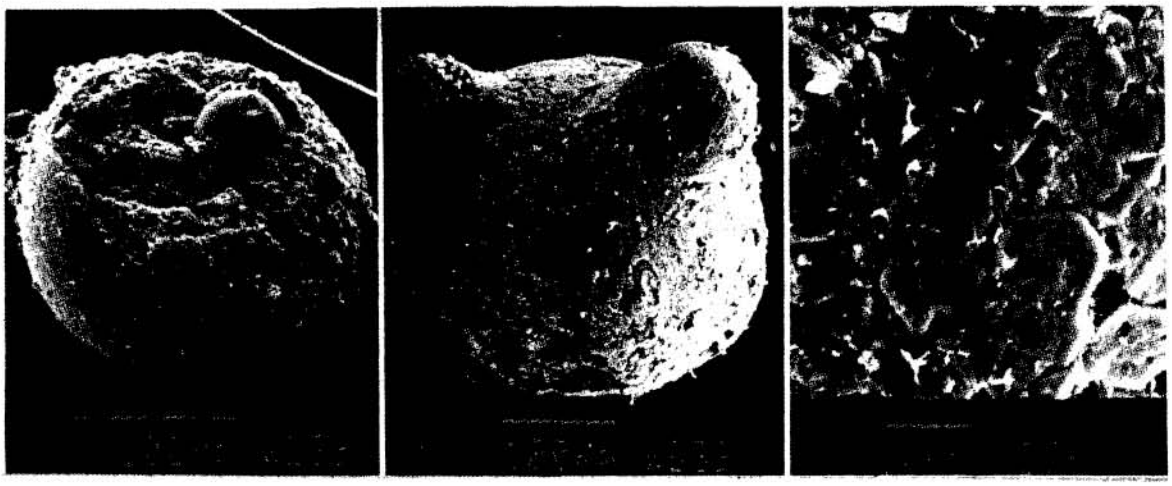

Figure 1 Figure 2 Figure 3

Fig 1: Fe-Ni sphere with Ni-core. Population 1.
2: Coalescent spherules: Population 2
3: Magnetite shell

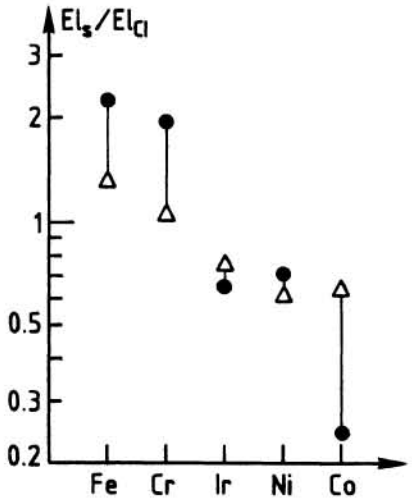

Fig.4:
Loppio abundance ratio (average of 22 fragments 650 µg).●
chondritic spherules, abundance ratios (average of 14 spherules 637 µg).△