SMALL GRAINS WITH HIGH LEAD CONCENTRATION IN CHAINPUR; J.L.A.M. Kramer, A.C. Kik and R.D. Vis, Department of Physics and Astronomy, Free University Amsterdam.

Using Particle Induced X-ray Emission (PIXE) [1], a small spot with an extremely high concentration of lead has been found in a Chainpur chondrule. This spot is about 70 micrometer in diameter with a maximum lead concentration of 5 wt. percent. An electron probe measurement revealed that the spot was consisted of even smaller grains, ranging in size from 1 up to 5 micrometer with lead concentrations of about 50 wt. percent. The grains are surrounded by enstatite. The isotopic ratios of these lead grains, determined with SIMS, fall on the Pb-Pb isochron with an age of 4.55 Gyr. According to the simple one-stage model we find for μ = $^{204}Pb/^{238}U$ a value of about 6.5, whereas the PIXE measurements showed a maximum uranium concentration of only 5 ppm. If contamination is ruled out, it is likely that a recent metamorphic event separated the lead from its source region. Other spots in the same sample have been found with the same chemical composition for lead compound.

Introduction. PIXE is a very powerful method for measuring trace element concentrations in situ on micrometer scale. Minimum detection limits of several ppm for elements of Z = 20 and higher are easily reached with a lateral resolution down to 4 micrometer [2]. Determining volatile trace elements like zinc in unequilibrated ordinary chondrites is our main goal of research. A Chainpur (LL3.4) chondrule has been studied for this reason [3]. The studied chondrule has a fine rim with some troilite and metal grains in it. Easy to recognize is a strange spot in the centre, which is embedded in mainly enstatite minerals together with some small pigeonite crystals. Rather high lead concentrations have been found in this region. Besides the PIXE measurements also one SIMS and one electron probe measurement have been performed. More spots with high lead concentration have been found in the same Chainpur sample but have not yet been studied extensively.

Measurements and results. To study this chondrule it has been scanned from one edge to the other in a PIXE measurement with a broad beam of about 8 by 20 micrometer. Protons with an energy of about 3.5 MeV were used, which produce detectable X-rays for lead down to roughly 30 micrometer deep in an average matrix. The very distinct spot of about 70 micrometer in diameter in the middle of the chondrule shows a maximum lead concentration of 5 wt. percent. The bulk concentration of lead in ordinary chondrites is around 1.0 ppm [4]. Also an electron probe measurement on the same spot has been performed to check the PIXE results. From the backscattered electron image in figure 1, it can be seen that lead is actually concentrated in small grains of a size of about 1 to 5 micrometers in diameter with even much higher lead concentrations. Results of both PIXE and EPMA measurements on one of these grains are shown in table 1. Galena (PbS) is one possible mineral for these small grains. However, since the M X-ray lines of lead interfere with the K lines from sulphur, it is not possible to determine sulphur with PIXE. In the gamma-ray spectrum, produced by Coulomb excitation of nuclei by 3.5 MeV protons, some sulphur was found on this spot but it was hard to quantify. Also one SIMS measurement was done and the results are depicted in a $^{207}Pb/^{204}Pb$ vs. $^{206}Pb/^{204}Pb$ diagram in figure 2. In spite of the rather large error bars, the measurement seems to fall on the isochron together with other chondrites. Assuming the single stage model to be correct, a μ of about 6.5 was found. PIXE showed much lower lead uranium ratios: an upper limit of uranium of 5 ppm and thorium of 18 ppm was measured (see table 1). Other PIXE measurements in the same sample showed more of this kind of spots, with roughly the same distribution of elements. Very apparent is the coincidence with zirconium. To assure the sample has not been spoiled by terrestrial lead, we also looked for traces of antimony, because this element generally occurs in industrial lead (6 wt. percent Sb), but it was not found at all in these grains.

Discussion. If the lead will be found in galena, the possibility of contamination from laboratory origin can be excluded. The grains were too small to be easily identified as galena under a microscope, although they were recognized with the help of the backscattered electron image. The SIMS measurement shows that the lead in the grain is quite normal radiogenic. The absences or low concentrations of uranium and thorium together with the high concentration of lead and a μ of roughly 6.5, indicates that the lead has been recently separated from its source. One might speculate about different events, but it seems most likely that it happened during a major collision which broke up the parent body, taking into account the low gas retention ages of chondrites of all groups [5].

Outlook. A new sample of Chainpur is being prepared for more measurements. In addition to measurements on this new sample, more electron probe and SIMS measurements will be performed on the other spots found in the original sample. It is important to find out what kind of mineral is involved, and to determine the isotopic ratios with higher accuracy on the other spots.

Table 1: **PIXE and EPMA results.**
*) PIXE measurement

lead spot		nearby mineral	
Si	17.0%	MgO	35.6 %
Fe	0.7%	SiO_2	57.6 %
Pb	49.9%	FeO	4.5 %
Zn	58.7 ppm*	CaO	2.0 %
Rb	6.0 ppm*	MnO	0.28%
Sr	22.4 ppm*		
Zr	267.0 ppm*		
Th	<18.0 ppm*		
U	< 5.0 ppm*		

figure 1. Backscattered electron image.

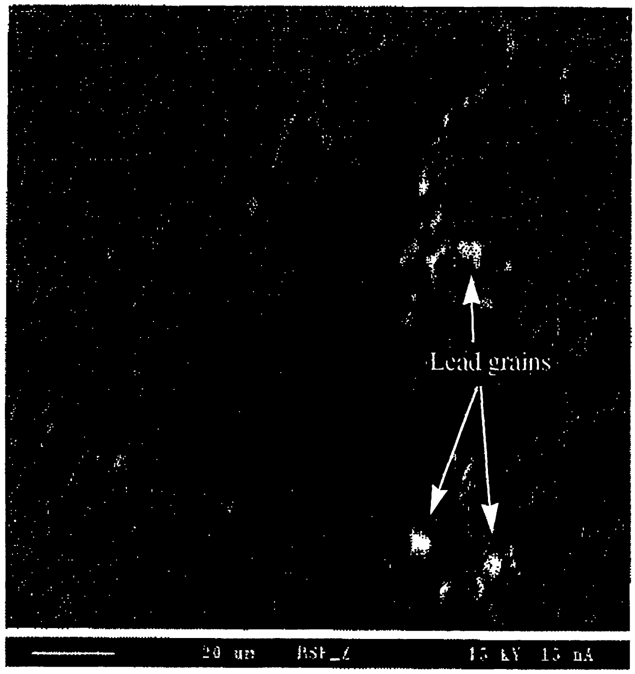
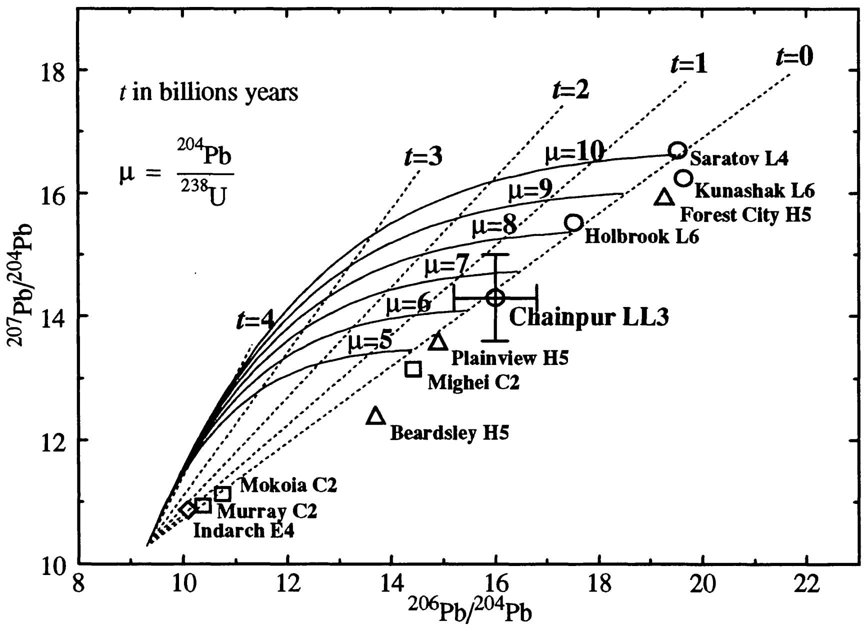


figure 2. $^{207}Pb/^{204}Pb$ vs. $^{206}Pb/^{204}Pb$ diagram. [4]



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References. [1] S.A.E. Johansson and T.B. Johansson (1976), *Nucl. Instr. Meth.* **137** 473-516. [2] K. Ishii and S. Morita (1988), *Nucl. Instr. Meth.* **B34** 209-216. [3] J.N. Grossman and J. Wasson (1982), *Geochim. Cosmochim. Acta* **46**, 1081-1099. [4] B. Mason, ed. (1971), *Handbook of Elemental Abundances in Meteorites,* Gordon & Breach Sci. Publ. [5] D. Heymann (1967), *Icarus* **6**, 189-221.