**Introduction:** $^{60}$Fe ($T_{1/2}=1.49$ My) is a key a short-lived radioactive nuclide because it is the only one for which an origin from irradiation by cosmic rays is impossible. $^{60}$Fe is a neutron-rich nuclei and its production rate during irradiation processes around the early Sun (because of the low cross sections of appropriate reactions and of the low abundance of targets) is at least two orders of magnitude too low to explain the observed abundance [1].

The problem is however that, though several evidences do exist for the presence of lived $^{60}$Fe in the early solar system, the inferred initial $^{60}$Fe/$^{56}$Fe ratios span a large range due either to an heterogeneity in the distribution of $^{60}$Fe or to perturbations of the $^{60}$Fe-$^{60}$Ni system in various meteoritic components, or to both. The presence of $^{60}$Fe has been discovered from the existence of $^{60}$Ni excesses in CAIs [2] and in eucrites [3]. However, because of the presence of nucleosynthetic Ni isotope anomalies in CAIs [2, 4] no initial $^{60}$Fe/$^{56}$Fe ratio can be determined precisely: an upper limit of $1.6\pm0.5\times10^{-6}$ has been proposed by [2] and a value of $4.7\pm2.9\times10^{-6}$ has been tentatively proposed by [4] from the analysis of CAIs with no $^{60}$Ni nucleosynthetic anomaly. Clear $^{60}$Fe isochrons have been obtained for troilite and magnetite in the matrix of Semarkona [5] and for pyroxene-rich chondrules from Semarkona and Bishunpur [6]. The problem is that the different $^{60}$Fe/$^{56}$Fe ratios are difficult to reconcile. Pyroxene-rich chondrules show a $^{60}$Fe/$^{56}$Fe ratio of 2.2-3.7$\times10^{-7}$ while the $^{60}$Fe/$^{56}$Fe ratio in the troilite in the matrix of Semarkona is of $0.9\pm0.2\times10^{-6}$, i.e. higher by a factor of $\approx 3$ to 4 compared to chondrules. Because high-precision Ni isotopic analyses of metal in chondrites and iron meteorites [7] limit the possible $^{60}$Fe heterogeneity in the inner solar system to less than 10%, the differences observed between the different components of Semarkona may be a sign of previously unrecognized secondary perturbations of the $^{60}$Fe-$^{60}$Ni system. Thus the initial $^{60}$Fe/$^{56}$Fe of the solar system remains at present quite unconstrained.

Better constrains on the initial $^{60}$Fe/$^{56}$Fe of the Solar system are required in the use of $^{60}$Fe as a smoking gun for injection of supernova products in the early solar system. Recent measurement of the $\gamma$-ray lines of $^{60}$Fe in the interstellar medium gives a value of $0.148\pm0.06$ for the galactic $^{60}$Fe/$^{26}$Al ratio [8] which, using the present day average galactic $^{26}$Al/$^{27}$Al ratio of $8.6\times10^{-6}$ [9] would imply a galactic background for $^{60}$Fe/$^{56}$Fe perhaps as high as $\approx1.4\times10^{-7}$. This is not one order of magnitude lower than initial $^{60}$Fe/$^{56}$Fe inferred from meteorites.

In order to bring additional constraints on the initial $^{60}$Fe/$^{56}$Fe ratio and on the possible perturbations of the $^{60}$Fe-$^{60}$Ni system, we looked for $^{60}$Fe in sulfides oxides and silicates from the eucrite NWA 4523.

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**Fig 1:** Isochron diagram showing $^{60}$Ni excesses versus $^{56}$Fe/$^{56}$Ni ratios for different phases, presumed co-magmatic, in eucrite NWA 4523. The top diagram is a blow up showing the nice apparent $^{60}$Fe isochron for the troilite. The bottom diagram shows that the $^{60}$Ni excesses in pyroxene are at odds with those which would be inferred from the troilite in case of simple closed system evolution of both phases.
Samples and analytical techniques:
NWA 4523 is a monomict eucritic breccia belonging to the Stannern trend [10]. It contains medium grain clasts with troilite, chromite and ilmenite crystals between 10 and 100μm size. This sample was chosen for a search of 65Fe because (i) eucrites being differentiated objects high Fe/Ni ratios are present in the various phases and (ii) the Petrography suggests that troilite and oxides are magmatic phases. The Ni isotope analyses were done with the CRPG-CNRS (Nancy, France) ims 1270 ion microprobe in monocollection mode at a mass resolution of 7000. Special care was taken to check for possible interferences due to peak tailing on the Ni isotope peaks. Three Ni isotopes at masses 60, 61, 62 were measured. Numerous analyses of terrestrial pyrohotite and olivine standards show that the 65Ni excesses can be determined at a precision of ±1.5 to ±2‰ (2 sigma). Errors on the NWA 4523 are mostly due to counting statistics.

Results and discussion: Results are shown in Fig 1. Large 65Ni excesses were found in troilite with a perfect apparent isochron suggesting a 65Fe/56Fe slope of 7.9±1.9x10^-7. The other phases show smaller 65Ni excesses with apparent 65Fe/56Fe slopes of 2.9x10^-7 in magnetite and at maximum of 2x10^-7 in silicates.

It is obvious that a 65Fe/56Fe ratio of 7.9x10^-7 makes no sense for a eucrite. A eucrite is coming from a differentiated body which has been homogenized by melting. Taking a bulk FeO content for eucrites of ≈17 wt% and a bulk Ni content of ≈4 ppm, for a 65Fe/56Fe ratio of 7.9x10^-7, 65Ni excesses of ≈90‰ should be present in bulk!

Such extreme 65Ni excesses do not exist in eucrites in bulk [e. g. 11]. Thus the nice 65Fe isochron shown by troilite in NWA 4523 must be secondary.

One way to produce such a secondary isochron would be to exchange Ni between troilite and surrounding phases during metamorphism after the decay of 65Fe (the only way to increase the slope of the 65Fe isochron is to decrease the Fe/Ni ratio after the decay of 56Fe). First order models of Ni exchange between troilite and oxides show that this is feasible. A proof for the fact that troilite cannot be considered as a closed system during metamorphism is the Cr and Ti diffusion profiles observed at contact with chromite and ilmenite (Fig 2). Such a redistribution of Ni may also explain part of the differences in 65Fe/56Fe observed in the different phases in Semarkona (difference between troilite in the matrix and pyroxenes in chondrules, see above).

Correlations between 65Ni excesses and 1/[Ni] (mixing lines) imply that most of the present data in NWA 4523 can be explained by a redistribution of Ni after the decay of 65Fe if the 65Fe/56Fe at the time of metal-silicate differentiation on the eucrite parent body was at maximum of 1.4x10^-8.

This seems consistent with a 65Fe/56Fe of ≈4x10^-10 at the end of metamorphism [3, 11]. If eucrites differentiated ≈4 Ma after the formation of CAIs [12, 13], then the solar system initial 65Fe/56Fe which would be implied by the present data is of 0.7-3x10^-7.