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ANOMALOUS Ca AND Ti IN A HERCYNITE-HIBONITE INCLUSION FROM LANCE

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An ~ 160 × 230 µm inclusion (HH-1) from Lance consists of approximately equal portions of hibonite and hercynite (27-30% FeO, 7.5% MgO), the hibonite comprises the center of the inclusion, the hercynite the outer regions; petrographically, the hercynite appears to be an alteration product of previously existing hibonite. An ~ 15 µm thick diopside rim surrounds the inclusion followed by a layer of less Ca-rich pyroxene. Numerous perovskite grains (≤ 5 µm) are distributed throughout the inclusion. Also present are two ilmenite grains ~ 5 µm in diameter.

Ion probe measurements of Ca and Ti isotopes reveal large anomalies in all phases analyzed (see Table 1). The Ti isotopic composition is identical in hibonite, perovskite, hercynite, and ilmenite indicating a common origin of the Ti in these phases. The large negative $\delta^{50}Ti$ in hibonite is accompanied by large negative $\delta^{48}Ca$ similar to observations in CM hibonites (Zinner *et al.*, 1986) and in the FUN inclusions EK-1-4-1 and C-1 (Niederer *et al.*, 1980). The Ca in the hibonite also exhibits negative $\delta^{42}Ca$ and $\delta^{43}Ca$ effects that have previously not been observed. A gradient in the Ca isotopic composition from the central hibonite to the outer pyroxene rim suggests either formation of the outer layers from a reservoir that had undergone more mixing with solar system Ca or back reaction with a reservoir of isotopically normal Ca. Our results extend the observation of large Ti and Ca anomalies from CM and CV meteorites (Zinner *et al.*, 1986; Niederer *et al.*, 1980; Fahey *et al.*, 1985; Ireland *et al.*, 1985; Hinton *et al.*, 1987) to CO chondrites. They also provide evidence for additional complexity with regard to Ca nucleosynthetic components.

Table 1

Ti isotopic composition

Sample	$\delta^{47}Ti \pm 2\sigma$	$\delta^{49}Ti \pm 2\sigma$	$\delta^{50}Ti \pm 2\sigma$
Hibonite 1	-1.2 ± 2.9	-9.7 ± 2.5	-57.7 ± 3.4
Hibonite 2	-5.9 ± 3.9	-9.4 ± 3.4	-59.3 ± 5.6
Perovskite 1	-3.0 ± 2.7	-13.6 ± 2.7	-63.2 ± 3.6
Perovskite 2	-1.4 ± 2.0	-11.6 ± 2.7	-61.9 ± 2.9
Ilmenite 1	-3.3 ± 4.1	-8.7 ± 3.8	-60.5 ± 5.2
Hercynite B	-4.1 ± 3.2	-11.4 ± 3.1	-60.7 ± 4.2

Ca isotopic composition

Sample	$\delta^{42}Ca \pm 2\sigma$	$\delta^{43}Ca \pm 2\sigma$	$\delta^{48}Ca \pm 2\sigma$
Hibonite 1	-8.0 ± 2.8	-5.2 ± 3.7	-33.6 ± 4.3
Hibonite 2	-5.7 ± 2.8	-4.9 ± 2.9	-31.8 ± 3.3
Diopside rim	-3.5 ± 3.4	-1.6 ± 3.4	-21.0 ± 4.0
Outer Px rim	1.5 ± 3.0	-1.6 ± 4.2	-8.3 ± 4.3

Magnesium isotopes were measured in the hibonite and hercynite of HH-1 and were found to have excess ^{26}Mg. However, the excess ^{26}Mg is not correlated with the $^{27}Al/^{24}Mg$ ratio and is inhomogeneously distributed on a size scale of several microns. The Mg in HH-1 has either been redistributed after the decay of ^{26}Al or fossil $^{26}Mg^*$ was present when the inclusion formed.

REE were measured in the hibonite, hercynite, and pyroxene of HH-1. The pyroxene pattern is flat at about twice chondritic. Given above are two typical patterns from hibonite and hercynite. The most striking thing about these two patterns is that the hercynite is enriched in the heavy REE with respect to the hibonite which would not be expected if the hercynite were an alteration product of the hibonite.

Fahey *et al.*, 1985. *Ap. J.* **269**, L17-L20.
Hinton *et al.*, 1987. *Ap. J.*, in press.
Ireland *et al.*, 1985. *GCA* **49**, 1989-1993.
Niederer *et al.*, 1980. *Ap. J.* **240**, L73-L77.
Zinner *et al.*, 1986. *Meteoritics* **21**, 547.

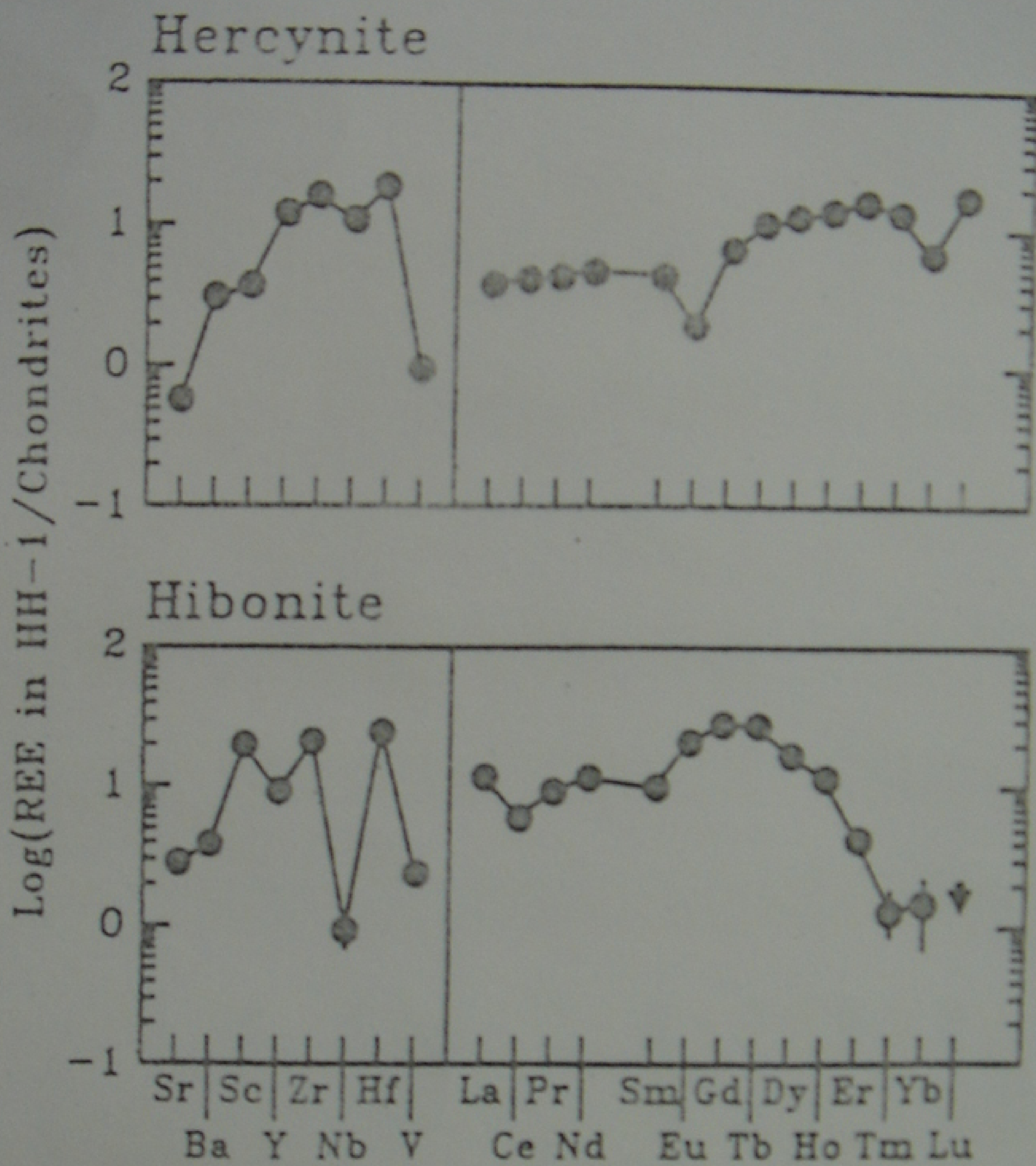

Fig. 1

FORMATION OF DUST GRAINS IN COOL STELLAR ATMOSPHERES: THERMOCHEMICAL KINETIC MODELS

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The gas phase equilibrium chemistry and gas-solid condensation reactions for a large suite of elements and their compounds are calculated using chemical equilibrium codes specifically developed for this purpose. The results are coupled with literature data on the thermochemical kinetics of important homogeneous and heterogeneously catalyzed gas reactions to provide a model of expected molecular abundances in various model stellar atmospheres. Nucleation theory is also used to discuss some aspects of grain formation such as the question of graphite nucleation in carbon-rich model atmospheres.

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