and CV3 matrices and conclude instead that these minerals formed by fluid-rock interaction during asteroidal alteration.

Salt-rich, hydrous, carbonaceous chondrites are rich in hydrated silicates and sulfides. These minerals form during aqueous alteration and subsequent dehydration during the thermal metamorphism of the objects [5, 6]. These alterations occur in the presence of water, inducing the formation of clay minerals, serpentine, and carbonates. The hydrated minerals are often present as fine-grained aggregates, which may be observable using X-ray diffraction (XRD) or Raman spectroscopy.

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Fig. 1. Normalized trace-element abundances in chondrule 94-4-32 (as measured by SIMS) compared to those of two RP chondrules from Allende, Ach-1 and Ach-2 [5].

Bulk composition of 94-4-32 is chondritic but enriched in CaO (3.6 wt%), and depleted in NiO (0.02 wt%), K2O (<0.02 wt%), and SO3 (0.23 w%) compared to chondrules. However, trace-element abundances (Fig. 1) are distinctly different from those in chondrules. All highly refractory elements (Zr, Y, Th, Sc, Sm, Gd, Tb, Dy, Ho, Er, Tm, Yb, and Lu) have chondritic abundances (0.007–0.7x CI), whereas the moderately refractory elements (Ti, Nb, La, Ce, Pr, Nd, Eu, Be, Si, and Ba) have superchondritic abundances (2–7x CI). The moderately volatile elements Li and Cr have approximately chondritic abundances, and Co and Ni have subchondritic abundances.

The depletion of 94-4-32 in siderophile elements and the presence of pentlandite can be taken as additional indications for that particle being a chondrule. Fractionation of lithophile-element abundances have been observed in chondrules from a few chondrites [e.g., 22] and are probably due to sampling fractionation. Chondrule 94-4-32, however, has lithophile-element abundances that clearly reflect vapor fractionation, comparable to that found in type I CAIs [4], and thus gives evidence for the formation of that chondrule by condensation from a vapor that was depleted in superrefractory elements. A condensation origin of some chondrules, like the RP chondrules, has been shown to be likely because of vapor-fractionated siderophile element abundances [5]. However, chondrule 94-4-32 is the first chondrule found so far that carries an unequivocal signal of condensation in its lithophile-element abundance. Chondrule 94-4-32 and Cs with similar trace-element patterns indicate that such material is apparently more abundant in the interplanetary dust, which bears compositional similarities to CM/Cr chondrules [6], than in chondrules, but what does this imply?

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Millimeter-sized spinels, now altered to clay minerals, are reported in many Cretaceous-Tertiary (K/T) boundary sites [1,2]. Two types of spinels can be distinguished based on their morphology, the presence of high-temperature phases, their geographic distribution, and their stratigraphic position within the K/T boundary layer [3,4]. Rounded (but elongated or tear-shaped) spinels, some with preserved glass core and target rock composition [5–7], are found only at proximal sites at the base of the K/T boundary layer. Two similar types, similar to meteorites, are found worldwide, associated with the uppermost part of the K/T boundary layer. These spinels are always spherical and typically contain a high-temperature phase in the form of Ni-rich magnesioferrite spinels [8–10]. This study deals only with this second type of spinel, in particular the magnesioferrite phase. Similar magnesioferrite-bearing spinels are found in meteorites, fusion crusts, cosmic spinels, and sediments from the Cretaceous-Paleogene boundary in Massignano (Italy), and Late Paleocene sediments containing debris from a