KINETICS AND MECHANISM OF EXSOLUTION OF Ru-Fe IN THE SYSTEM Fe-Ni-Ru: IMPLICATIONS FOR THE ORIGIN OF REFRACTORY METAL NUGGETS IN CAIs. N.Z. Boctor[1], T.N. Irvine[1], and H. Palme[2], [1]Carnegie Institution of Washington, 5251 Broad Branch Rd., NW, Washington, DC 20015; USA, boctor@gl.ciw.edu [2]Mineralogisch-Petrographisches Institut Zulpicher Strasse 50674 Koln Germany

Introduction: Refractory metal nuggets (RMNs) in opaque assemblages composed mainly of NiFe metal, Fe-Ni sulfides and magnetite occur in CAIs. Some investigators believed that they record nebular conditions prior to the formation of the CAIs, whereas others attributed their origin to exsolution, oxidation and sulfidization of homogeneous alloys within the host CAIs during slow cooling (500°C) in the nebular or in a planetary environment. Regardless of their origin, their refractory sidrophile elements form solid solutions with Fe-Ni alloys during melting of the CAIs and then begin to exsolve during subsolidus cooling Therefore, the study of the kinetics and mechanism of exsolution of refractory sidrophile elements from Fe-Ni alloys should provide clues on their cooling and equilibration history.

Experimental Techniques and Results: Homogeneous synthetic Fe-Ni-Ru alloys were prepared by melting puratronic-grade metals in alumina tubes at an oxygen fugacity two log units below the iron-wustite buffer The homogeneity of the alloys were verified by the electron microprobe. The alloys were annealed isothermally under subsolidus conditions for 1 to 390 days. The progress of exsolution as a function of time was determined from electron microprobe X-ray maps. Three isothermal rate studies were performed at 800, 700, and 600°C. The experimental results show that the exsolution rate depends on temperature and supersaturation. The percent of exsolution shows a positive correlation with temperature and the degree of supersaturation.

Discussion: Three mechanisms of exsolution are known. The continuous mechanism involves nucleation of the exsolved phase and its growth by volume diffusion. The discontinuous mechanism involves nucleation of duplex cells of two phases of approximately equilibrium compositions and growth by grain boundary diffusion along the incoherent boundary with the host. Spinodal decomposition, a process that may replace the nucleation event in the continuous mechanism, proceeds by growth of compositional perturbations small in degree but large in extent and a new phase gradually emerges that is structurally coherent with its surrounding across a diffuse interface.(Yund and McCallister,1970) For any given temperature,in our experiments the exsolved phase has a fixed composition (within the analytical uncertainity) which precludes spinodal decomposition as the mechanism of exsolution. At 700 to 800°C, the formation of of RuFe nuclei and their growth as a function of time are consistent with exsolution by the continuous mechanism. At 600° C, formation of duplex cells was observed consistent with exsolution by the discontinuous mechanism. In CAIs, RMNs occur as granule and rarely as sparse lamellae. These are mimiced by the textures in our experiments in which the mechanism of exsolution was the continuous mechanism .No evidence of cellular preciptation was observed in any natural RMN so far. Therefore, it is likely that exsolution ceased to occur at temperatures below 700°C.Exsolution of theRMNs may have occurred in the solar nebula .Oxidation and sulfidization of the Fe-Ni alloys may have proceeded at lower temperatures either in the nebula or in a planetary enviroment.