**OBJECTIVES:** Understanding the environments and isotope reservoirs of R chondrite forming regions.

**Characteristics of R chondrites [1-7]**
- FeO-rich olivine (Fa88) in equilibrated lithologies
- High bulk δ17O (+0.52±0.02‰) values (~2.7‰)
- A wide range of δ17O in chondrules (~4‰ to +3‰)

Oxidized nebula setting with 16O-depleted oxygen isotope reservoirs?

**Search for least equilibrated R3 clasts**
Most R chondrites are of lower petrologic types (R3 and R4), though unequilibrated R chondrites with subtypes lower than 3.6 are not known. Many R chondrites are regolitic breccias containing R3-6 clasts. Unequilibrated R3 clasts (<3.5) have been observed in brecciated R chondrites [4,5].

In order to identify primary oxygen isotope signatures in R chondrite chondrules, we need to search for R3 clasts that experienced minimal parent body metamorphism, equivalent to lowest subtypes (≤3.2).

We performed detailed petrographic descriptions of chondrules in a highly unequilibrated R3 clast from Northwest African (NWA) 753 (R3-5) chondrite (Figs. 1, 2). The goal of the study is to determine if the clast is suitable for detailed SIMS oxygen isotope analyses.

- NWA 753 Type IX (8 mm × 4 mm)
- We found 69 chondrules ≤200 μm in size
- BSE imaging (Hitachi S-3400N SEM)
- SEM-EDX analysis for identification of phases
- Electron Microprobe analyses ( Cameca SX51 )

**Chondrules in R3 clast NWA 753-IX**
Most chondrules show porphyritic textures, while minor non-porphyritic chondrules and two Al-rich chondrules [8] are also identified (Table 1, Fig. 3). The proportion of different types of chondrules are very similar to LL3 chondrites [9], especially with respect to similar abundances of type I and II chondrules, while type II chondrules are less abundant in carbonaceous chondrites (~25% in CO3 and 55% in CR3 [10-11]). All non-porphyritic chondrules are FeO-rich.

Mesosites of chondrules are mostly altered compared to unaltered mesosites seen in type 3.0 chondrites (such as Semarkona [8]) and often include areas with high Na and Cr contents (Fig. 4).

**Distribution of Chondrule Mg#**
The FeO contents of olivine and pyroxene phenocrysts are related to the oxygen fugacity of the chondrule-forming environments [12]. The distribution of Mg# of chondrules in the R3 clast (Fig. 5) is similar to that of LL3, in contrast to carbonaceous chondrites with abundant highly reduced chondrules (Mg#<≈95). These data indicate that many chondrules in both unaltered chondrite and R chondrite regions formed under more oxidized conditions.

**Petrologic Subtypes**
Grossman and Brearley [16] suggested that the average and SD of CaO wt% in forsterite olivine grains can be used as an index of low petrologic subtypes from 3.00 to 3.15. The data estimated for the R3 clast NWA 753-IX plot close to the subtypes 3.15-3.20 for ordinary chondrites (Fig. 7). By assuming the classification scheme for ordinary chondrites can be also applied to R chondrites the data suggest that clast NWA 753-IX is the least metabolized R3 chondritic material compared to other R3 chondrites (≥3.6).

**Future Work:** Oxygen isotope Analysis
Group-specific Mgδ17O trends: High precision SIMS oxygen isotope studies of chondrules in least equilibrated chondrites (Fig. 8). LL, CO, CR, and Acfer 004 with subtypes ≤3.2 revealed group-specific trends between the Mg# and δ17O values of chondrules [e.g., 9, 11, 13-14]. These results provide important clues to identify the variety of isotope reservoirs and their evolution in each chondrule forming region.

Both high and low δ17O values (+2.7‰ and −4.0‰) from Mg-rich chondrules (Mg#>99) have been reported for chondrules in R3.6 [7], which are important in understanding the origin of 16O-poor isotope reservoirs in the solar nebula.

**SUMMARY**
- Highly unequilibrated R3 clast NWA 753-IX contains a variety of chondrules with Mg#s of 100-67.
- The petrologic subtype is estimated to be 3.15-3.2, suitable for detailed oxygen isotope study.
- More R3 clasts need to be examined.

**References:**