

**Re-Os ISOTOPE SYSTEMATICS in the CAPE YORK METEORITE SHOWER.** M.I. Smoliar<sup>1</sup>, R.J. Walker<sup>1</sup> and J.W. Morgan<sup>2</sup>. <sup>1</sup>Dept. of Geol., Univ. MD, College Park, MD 207421, <sup>2</sup>Colorado State University, Fort Collins, CO

Here we report results of Re-Os isotope analyses of a suite of Cape York individuals (Agpalilik, Savik I, Thule, and Woman) along with other IIIAB members close in chemical composition to Cape York (Casas Grandes, Loreto, and Trenton). The analytical procedures were described in [1]. The IIIAB parent core had complicated crystallization history which cannot be described solely by fractional crystallization (e.g., scatter in Ni-Ir data along theoretical crystallization trends is much wider than analytical uncertainties) [2]. Meteorites from the Cape York shower demonstrate anomalous behavior for many trace elements, probably reflecting other major process. The high iridium part of the group IIIA irons (presumably representing the central part of the parent IIIAB core) was precisely dated by Re-Os method in this lab [3]. Consequently, the aim of the present study is to decipher the chronology of the Cape York irons relative to the IIIA isochron and to obtain precise Re-Os composition data in order to place additional constraints on conceivable models on the history of the IIIAB parental core.

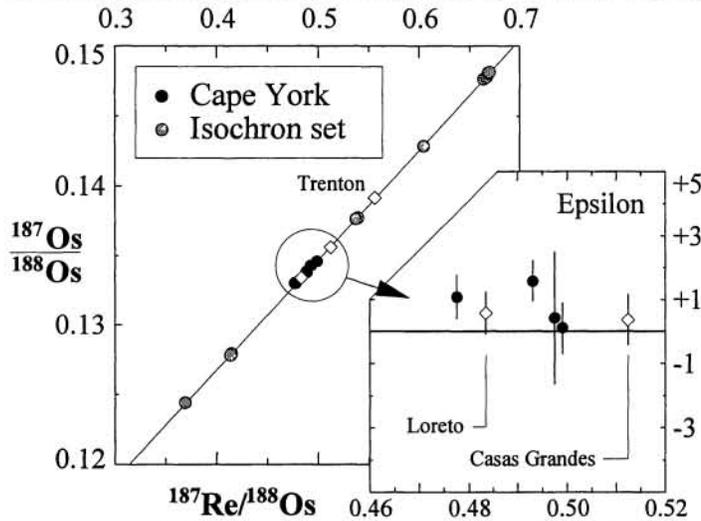


Figure 1. Re-Os isotope results for IIIA irons and Cape York

Throughout the moderate range of Re concentrations (from 223 ppb in Agpalilik to 445 ppb in Savik I) Os concentrations closely follow Re, maintaining an almost constant Re/Os ratio (Fig. 2). Such behavior is in clear contrast to general Re-Os crystallization trends for the IIIAB group.

The chemical evidence, along with isotopic data, place rigid constraints on tentative models of formation of the Cape York suite within the IIIAB core. Three models are considered:

1. **Fractional crystallization** with distribution coefficients ( $D$ ) substantially different from typical IIIAB values (due to local deviation in S and/or P content). Such a model applied to the Cape York suite requires  $D_{Re} = D_{Os}$  to produce a trend with constant Re/Os ratio. In the previous work [3] we analyzed four major magmatic iron groups which cover the whole range of S contents which occur in iron meteorites. The corresponding range in  $D$  is quite large (e.g.,  $D_{Re}$  changes from 1.4 in IVB irons to 22 in IIA irons). However, our results show, that despite a wide range in absolute values,  $D_{Re}$  and  $D_{Os}$  change very similarly, so that the term  $(D_{Re} - 1)/(D_{Os} - 1) = 0.82 \pm 0.02$  through the entire range of sulfur contents. Therefore, one can conclude that  $D_{Re} = D_{Os}$  is highly unlikely in any normal system..

**Chronology:** All Cape York samples show very similar Re/Os ratio (the range is only about 4%), therefore they don't define an isochron. All Cape York points plot above the IIIA isochron [3], although the deviation for each particular point is not very pronounced (Fig. 1). However, treated together they all give a weighted average of  $+1.0 \pm 0.4$  ( $\epsilon$ -units) above the isochron. Converted to a model age, the weighted average gives  $4576 \pm 5$  Ma (confidence limit takes into account analytical errors only), or, relative to the IIIA isochron [3] it is  $18 \pm 5$  m.y. older. This result is in good concordance with the Cr-Mn formation interval for Cape York [2]. These authors report Cape York to be  $14 \pm 3$  m.y. older than a suite of IIIAB irons.

**Re-Os concentrations:** Isotope dilution data for Re contents in Cape York samples are in a good agreement with neutron activation data [2].

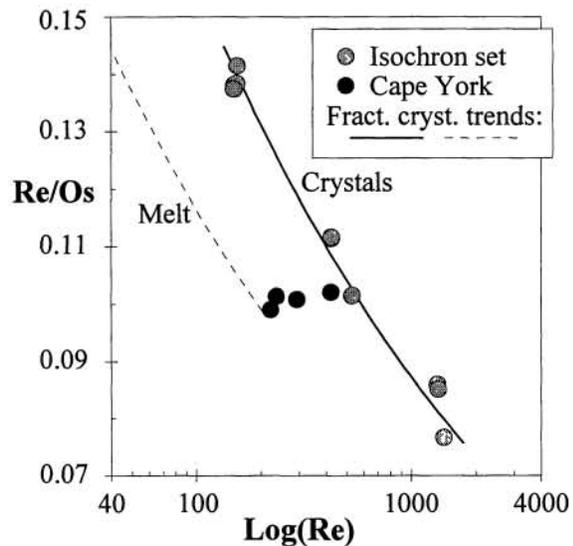


Figure 2. Distribution of Re and Os in IIIA irons and Cape York

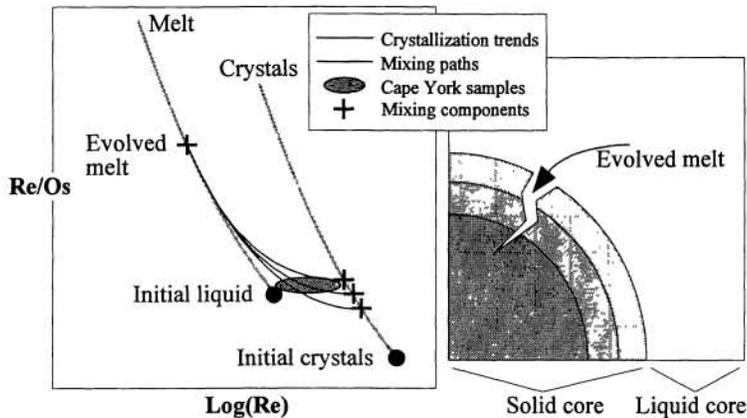
Re-Os SYSTEMATICS in CAPE YORK: Smoliar M.I. *et al.*2. Mixing - Several cases considering different mixing components.

Figure 3. Mixing of evolved melt with early portions of solid core.

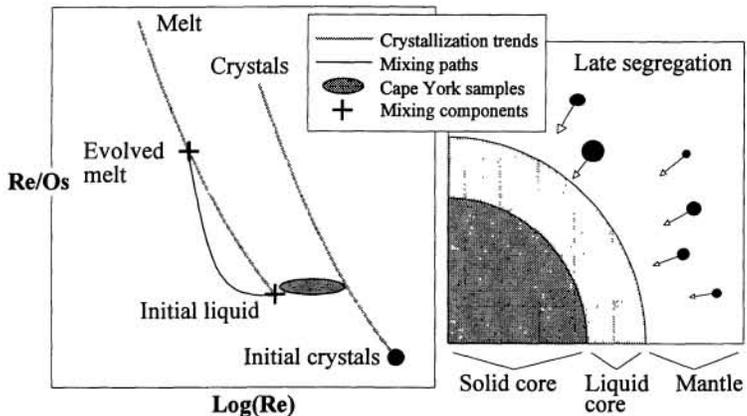


Figure 4. Late segregation of primitive metal into evolved melt.

non-magmatic irons (IAB, [4]) indicate that initial liquid compositions with respect to Re and Os were very similar. This makes external mixing with non-native primitive metal very similar to the previous case (late segregation).

3. Oxidation of iron with sulfur (or phosphorus). The distribution coefficients  $D_{Re}$  and  $D_{Os}$  for Fe,Ni - troilite system are very low [5, 6] implying that these elements remain in metal during the reaction  $Fe + S = FeS$ . A set of primitive metallic magma portions treated with S to a different extent and subsequently frozen will give linear Re-Os trend with constant Re/Os ratio exactly as in the case of Cape York. This model does not require any evolved material, therefore it does not place any time restrictions.

This latter model seems to be best explaining the present results. Also, it should be noted that we consider the chemical part of our results much stronger evidence than the model age (e.g., the isotope shift in Cape York could be alternatively explained by addition of isotopically anomalous metal). Consequently, we consider model 2a (early crystals + evolved melt) to remain a viable model.

**Other members of IIIAB group possibly related to Cape York.** We also analyzed three members of IIIA group which are close in chemical composition to the Cape York suite - Trenton, Casas Grandes, and Loreto. In respect to Ni, Ir, and Ga concentrations the first - Trenton - is very similar to Cape York individuals Thule and Agpalilik. However, Re-Os systematic (especially high Re/Os ratio) shows that it can not be related to Cape York suite. The other two are close to the high Ir part of the Cape York suite, and their Re-Os characteristics are also very similar. Casas Grandes has remarkable structural similarities to Savik I [2], so it is possible that Casas Grandes genetically belong to Cape York suite.

**References.** [1] M.I. Smoliar *et al.*, *LPSC XXVI*, 1323, 1996; [2] K.H. Esbensen *et al.*, *GCA*, **46**, 1913, 1982; [3] M.I. Smoliar *et al.*, *in press*, 1996; [4] M.I. Smoliar and R.J. Walker, unpublished data; [5] R.J. Walker *et al.*, *LPSC XXIII*; [6] D.A. Papanastassiou *et al.*, *Meteoritics*, **30**, 560, 1995

**Acknowledgements** - We thank Professor John T. Wasson for meteorite samples and helpful discussion. This work was supported by NASA grant NAGW 3625.

2a. Early crystals + evolved melt (Fig. 3). The right picture illustrates that this type of mixing could occur along fractures in a crystallizing core. The left diagram shows the modelling of Re - Os concentrations in mixtures - it is possible to get a trend similar to Cape York with this model. This model implies the beginning of core crystallization **prior to mixing**. However, our isotope results show the opposite sequence - Cape York samples seem to be older than the inner part of the IIIAB core (IIIa isochron).

2b. Evolved melt + primitive native metal (Fig. 4). This could occur as a late segregation of metal during core crystallization (right carton). Left diagram shows that it does not explain the actual chemical composition of the Cape York samples. Also, like previous model, it requires some part of the core to be solid at the time of mixing, which contradicts the isotopic results.

If we exclude *internal* mixing from processes which could produced the Cape York suite, there is also the possibility of *external* mixing - mixing where one component is an impact injected non-native metal. Our analyses of major groups of magmatic irons (IIAB, IIIAB, IVA, [3]) and