IIAB AND IIG IRON METEORITES ORIGINATED FROM A SINGLE PARENT BODY A. Anand[1], P. M. Kruttasch[1], K. Mezger[1], R. Windmill[2], B. A. Hofmann[1,3], R. C. Greenwood[2], and I. Leya[4], [1]Institut für Geologie, Universität Bern, Baltzerstrasse 1+3, 3012 Bern, Switzerland (aryavart.anand@geo.unibe.ch), [2]Planetary and Space Sciences, The Open University, MK7 6AA Milton Keynes, UK, [3]Naturhistorisches Museum Bern, Bernastrasse 15, 3005, Bern, Switzerland, [4]Physikalisches Institut, University of Bern, Sidlerstrasse 5, 3012 Bern, Switzerland.

Introduction: Different magmatic iron meteorite groups are thought to sample the cores of distinct parent bodies that experienced large-scale chemical fractionation, most notably metal-silicate melt separation. IIAB and IIG are two such magmatic iron meteorite groups with Ga and Ge contents in the general ‘‘II” range. While IIAB irons represent the second largest group that formed by fractional crystallization, with more than 140 entries in the Meteoritical Bulletin Database, IIG is a relatively small group with only 6 members. On element vs. Au diagrams, IIG data plot near the high-Au end of the IIAB field leading past researchers to suggest that both groups might have formed from the same magma and thus in the same asteroidal core [1]. Combined Cr and O-isotope data provides a means to identify possible genetic relationships among meteorite groups. However, to date, no O or Cr-isotopic data for either the IIAB or IIG groups have been available that could provide critical information regarding this genealogy. Previous studies have attempted to make connections between different iron groups in ε^{54}Cr vs. Δ^{17}O space, such as between IIIAB irons, main group pallasites and HEDs [2, 3], IIE irons and H chondrites [4], IVA irons and L/LL chondrites [5, 6], and the Eagle Station pallasite and CV chondrites [7].

The present study utilizes Cr and O isotope data from chromite/troilite inclusions in the Twannberg (IIG) and Sikhote Alin (IIAB) meteorites to investigate their potential association. Chromite and daubréelite are the major carrier phases of Cr in iron meteorites. Due to a high ‘‘native’’ ε^{54}Cr and low Fe/Cr (~0.5) ratio in chromite/daubréelite, the cosmogenic contribution to ^{54}Cr is negligible and hence no correction for spallogenic Cr is required [8, 9, 10]. Both chromite and daubréelite are rare phases in iron meteorites and in the absence of these phases, however, troilite can be used for Cr isotope analysis. In the case of troilite, high Fe/Cr (~400) combined with the typically long irradiation times for iron meteorites (Table 1) leads to significant production of spallogenic ^{54}Cr and appropriate corrections are necessary. The Cape York (IIIAB) iron meteorite was used as a control to check the calculations correcting for spallogenic Cr contributions.

Methods: A chromite and/or troilite fraction was obtained each from Sikhote Alin (IIAB), Cape York (IIIAB), and Twannberg (IIG). Chromite grains in the samples were first identified using an optical microscope and isolated in small whole-rock fragments. The fragments were digested in conc. aqua regia on a hot plate set to 90 °C for 48 h to completely dissolve the metal-sulphide dominated matrix, leaving behind residual chromite grains. Troilite fractions were obtained using a Dremel® micro drill. One part of the chromite fraction from Sikhote Alin and all of the recovered chromite fraction from Twannberg were consumed to measure O isotopes on a MAT 253 dual inlet mass spectrometer at the Open University following the protocol given in [11]. Chromite fractions from Sikhote Alin and Cape York and troilite fractions from Twannberg and Cape York were used to measure Cr isotopes on a Triton™ Plus TIMS at the University of Bern. Cr isotope data for chromite fractions were reported in [12]. For troilite fractions, Cr purification and TIMS analysis follows the protocol described in [10, 12]. ^{53}Cr and ^{54}Cr isotope compositions of the troilite fractions were corrected for spallogenic Cr contributions using the ^{53}Cr and ^{54}Cr production rates obtained for the interior of the iron meteorite Grant (2.9×10^{11} atoms/Ma, [13]), the relation described in [14], and assuming a similar depth dependency as used in [15].

Results and Discussion: Δ^{17}O and spallogenic corrected and uncorrected Cr isotope data of the selected chromite/troilite fractions are listed in Table 1. The ^{53}Cr and ^{54}Cr data, corrected for spallogenic contributions, for the troilite fraction of Cape York is in perfect agreement with its chromite fraction, which does not need any correction, validating the correction procedure (Fig. 1). Since, the pre-atmospheric size of both Cape York ($r \geq 120$ cm [16]) and Twannberg ($r \geq 200$ cm [17]) is similar, the correction procedure for spallogenic Cr applied to Cape York troilite should also be valid for troilites from Twannberg. However, the pre-atmospheric radius of both Twannberg and Cape York is significantly larger than the pre-atmospheric radius of Grant ($r \geq 40$ cm [18]) which is used to determine ^{53}Cr and ^{54}Cr production rates [13]. Hence, the correction for spallogenic Cr could be slightly overestimated. As a consequence, the corrected ^{53}Cr and ^{54}Cr data constrain lower limits.

A large uncertainty of the CRE age of the Twannberg meteorite (182 ± 45 Ma) results in a large uncertainty of corrected ^{53}Cr and ^{54}Cr data for the troilite fraction (Fig. 1). Nevertheless, the Cr troilite from Twannberg data are in agreement with the Cr chromite data from Sikhote Alin, as well as with the other two

IIAB iron meteorites studied in [10]. Spallation corrected ^{53}Cr of the troilite fraction from Twannberg, translates into $^{53}Cr/^{52}Cr$ model ages using the relationship given in [10], constrains core formation in the Twannberg iron meteorite parent body to 0.7 ± 2.0 Ma after CAI formation, which agrees with the mean core formation age of ~1.3 Ma for IIAB iron meteorites [10].

The Twannberg troilite data, if combined with $\Delta^{17}O$ isotope data of its chromite fraction, shows a clear overlap with the data from Sikhote Alin when plotted on an $\varepsilon^{54}Cr$ vs. $\Delta^{17}O$ diagram (Fig. 2). Moreover, both Twannberg and Sikhote Alin lie in the fields for ureilite/acapulcoite-lodranite meteorites. Such an overlap suggests that IIAB and IIG are derived from a common isotope reservoir with the same O-Cr isotope composition. Additionally, chemical element trends for IIAB and IIG irons suggest a genetic relationship between both groups, with IIG formation from the evolved IIAB metal melt.

Group IIG irons were most likely formed from a P-rich metal melt that separated due to liquid immiscibility in the later stages of the IIAB core crystallization [1,20]. The chemical element trends from Wasson and Choe (2009) [1] and O-Cr isotope data in the present study provide a strong argument in favor of the origin of IIAB and IIG iron meteorites within the same asteroidal core, which might be the core within the ureilite/acapulcoite-lodranite O-Cr field.

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Table 1. Cr-and O-isotope composition of samples.

Sample	Fraction	CRE age	Fe/Cr	$\varepsilon^{53}Cr \pm 2se$	$\varepsilon^{54}Cr \pm 2se$	$\Delta^{17}O \pm 2se$
Twann	Troil.	182 ± 45	352.6	0.01 ± 0.02	-0.31 ± 0.04	
	corrected	182 ± 45	352.6	-0.25 ± 0.13	-1.12 ± 0.40	
	Chr.	182 ± 45	-	-	-	-1.11
CY	Troil.	82 ± 7	~350	-0.07 ± 0.04	-0.46 ± 0.09	
	corrected	82 ± 7	~350	-0.19 ± 0.04	-0.82 ± 0.09	
	Chr.	-	0.46	-0.20 ± 0.04	-0.78 ± 0.06	
SA	Chr.	-	0.41	-0.23 ± 0.03	-0.92 ± 0.05	-1.16 ± 0.01

Twann: Twannberg (IIG), CY: Cape York (IIIAB), SA: Sikhote Alin (IIAB). Chr.: Chromite, Troil.: Troilite. References for CRE ages: Twannberg [17], Cape York [19].

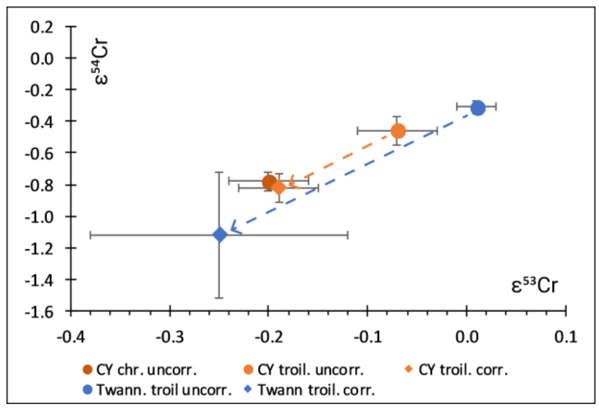

Fig. 1. Spallogenic Cr correction in troilite fractions from Twannberg (IIG) and Cape York (IIIAB) iron meteorites.

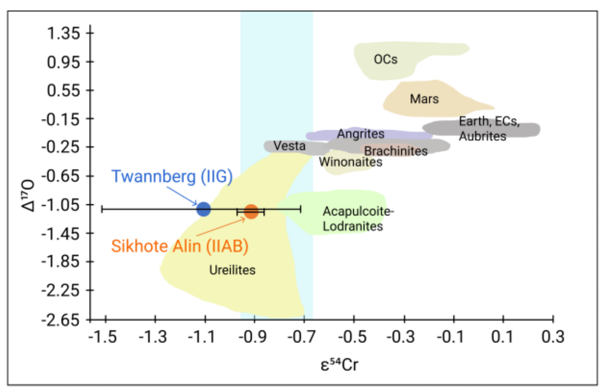

Fig. 2. $\Delta^{17}O$-$\varepsilon^{54}Cr$ diagram for Twannberg (IIG) and Sikhote Alin (IIAB). The overlap in the isotope data supports an origin of both IIAB and IIG iron meteorites from a common isotope reservoir with the same O-Cr isotope composition and thus a genetic relationship between the two iron meteorite groups. The blue vertical bar represents the $\varepsilon^{54}Cr$ variation in IIAB iron meteorites [10].