Re-Os SYSTEMATICS AND HSE DISTRIBUTION IN TIESCHITZ (H3.6): TWO ISOCHRONS FOR ONE METEORITE.

M. I. Smoliar[1], M. F. Horan[1], C. M. O'D. Alexander[1], and R. J. Walker[2], [1]Department of Terrestrial Magnetism, Carnegie Institution of Washington (5241 Broad Branch Road NW, Washington DC, 20015, USA; smoliar@dtm.ciw.edu), [2]Department of Geology, University of Maryland, College Park, MD 20742, USA.

Introduction: Tieschitz is an ordinary chondrite that displays some unique features. So called "white matrix" and "bleached chondrules" are found in only few chondrites, while in Tieschitz they are significant components. These phases have been the object of numerous studies (e.g., [1] and references therein), and are generally considered to be formed by secondary alteration or even redeposition. A Sm-Nd study of selected chondrules from Tieschitz [2] yielded a surprisingly young apparent age of 2.0 Ga, which most likely reflects the time of the alteration process. This makes Tieschitz very interesting with respect to providing a record of a young alteration event.

Experimental methods and samples: For this study, we obtained a sample of Tieschitz from the Vienna Museum (C794) which was pre-crushed to sub-cm chunks by ultrasonic treatment in distilled water. Clean un-processed samples were not available.

For this work we used the same general procedure as in our previous chondrite study [3] with minor modifications. For small samples (< 20 mg) we used small Carius tubes (6 ml) with reduced reagents (~ 8 times), and modified Os extraction protocol. This resulted in improved total analytical blanks, which were 0.5 pg and 0.8 pg for Re and Os correspondingly.

The instrumental part of our procedures were also slightly modified: during this study we made all Re analyses using the Plasma-54 ICP-MS. This technique gives better sensitivity than conventional TIMS. With respect to Os, samples with total Os > 1 ng were measured on the Sector 54 NTIMS (faraday multi-collector static mode) at the University of Maryland; samples with total Os < 0.5 ng were measured in on the 15 inch NTIMS (multiplier; dynamic mode) at DTM; and few samples with Os between 0.5 and 1.0 ng were measured on both machines to demonstrate absence of instrumental and data reduction biases within analytical errors.

With respect to HSE, the analytical procedures were the same as in our previous study [3]; total analytical blanks were 1 pg Ir, 20 pg Pt, 20 pg Ru, and 100 pg Pd.

Preliminary results for bulk magnetic separates for Tieschitz showed very limited variation in Re/Os ratio (~ 4%) and discordant positions on the isochron field, therefore, we confined further analyses to handpicked separates. We analyzed the following fractions (letters in brackets are datapoint labels used in the Fig. 1):

(M) – pure metal, coarse metallic grains with almost no silicates but with abundant dark patches which were confirmed by SEM to be iron oxide;

(Mc) – metallic chondrules, clean metal spheres with no visible accessory minerals on surface;

(Cb) – "black" chondrules, typically dark large chondrule fragments with clear radial or layered texture, almost pure low Ca pyroxene by SEM.

(Co) – olivine chondrule fragments, large and clear olivine crystals;

(Cn) – "nice" chondrules, large chondrules displaying clean surface with no signs of damage or alteration;

(Bp) – single large white pocket, analyzed in bulk after most of dark rims were removed;

(Bm) & (Bn) – bleached chondrule fragments, which were powdered and then separated with hand magnet into non-magnetic (Bn) and magnetic (Bm) fractions.

Results and Discussion: Rhenium-Os data for all unaltered chondrule fractions and metallic fractions of Tieschitz (Fig. 1, circles) form a line that yields an age of 4.59 ± 0.09 Ga. This age is within the error of the age we obtained for Ochansk (4.585 ± 0.025 Ga). Rhenium-Os distributions in these two meteorites are very similar: in both cases low Re/Os ratio end of the isochron is controlled by olivine (or olivine-troilite-rich) fractions, coarse-grain metal fractions plot on the high Re/Os ratio end, and most of fine metal samples and bulk chondrules plot in the center, close to the average chondritic Re/Os ratio. Also, samples from both meteorites with similar Re/Os ratios display very similar HSE patterns. These observations allow us to conclude that Tieschitz samples in the isochron set represent unaltered material that preserved its primordial isotopic and chemical compositions. At the same time the total rock sample (shown as square in Fig. 1) displays a pronounced deviation from the isochron, indicating the presence of altered material.

Three samples in our study refer to alteration products in Tieschitz. On Fig. 1 they are shown as diamonds. The typical appearance of bleached chondrules and white matrix is shown on photographs in Fig. 2. Bleached chondrule fragments were handpicked. Dur-

ing hand separation, it is difficult to avoid dark chondrule rims, which could contain unaltered material. Therefore, after handpicking the sample was powdered and separated using a strong neodymium magnet into non-magnetic (Bn) and magnetic (Bm) fractions. On Fig. 1, while the Bn fraction shows a pronounced deviation from the pristine isochron, Bm plots exactly on the isochron. Also, the Bm fraction has a flat HSE pattern and Re/Os ratio very close to average chondritic. We conclude that it is mostly comprised of fine unaltered metal. The two other samples, Bp and Bn, both show significant deviation from the pristine isochron. Their tie-line yields an apparent age of 2.0 ± 0.2 Ga which is in good agreement with Sm-Nd obtained for Tieschitz chondrules [2]. The HSE patterns in these samples are similar to each other, but dramatically different from any chondritic patterns we observed so far. In particular, both samples show strong Ir/Os fractionation, which gives a hint that the alteration process involved oxidation of Os.

Summary: Our new data confirm the potential of Re-Os system to date alteration events in studies of chondrites with complex histories. Almost all major and accessory phases in the chondrites bear Re and Os at levels which are easily measurable with modern techniques, and the Re/Os ratios are sufficiently variable to yield accurate isochrons. The HSE distribution patterns determined along with Re-Os data provide complementary evidence for interpreting the Re-Os systematics, as well as the nature of the processes that set chemical record.

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References:

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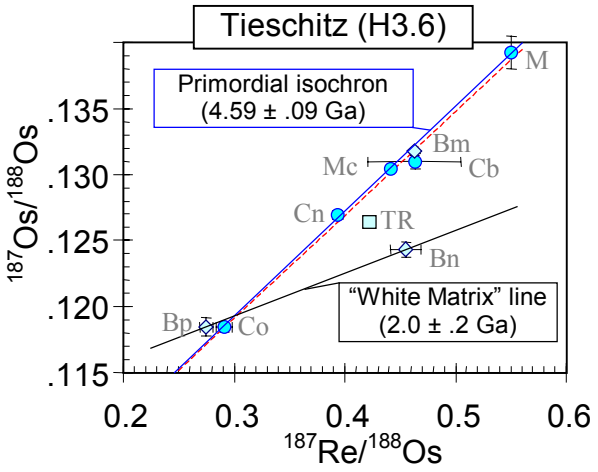

Figure 1. Re-Os systematics in Tieschitz. Circles represent isochron set and refer to unaltered samples: metal fractions (M, Mc) and several types of chondrules (Cb, Cn, Co). Square represent total rock (TR), and diamonds show samples of white pocket (Bp) and bleached chondrules (Bn, Bm). Dashed line represent our isochron for Ochansk [3]

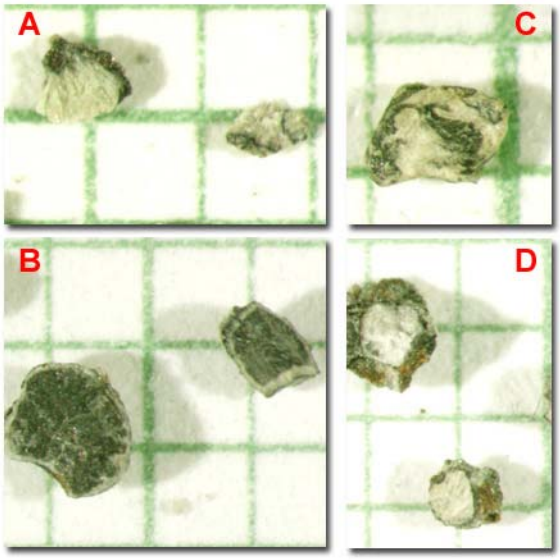

Figure 2. Photomicrographs of Tieschitz fragments (Background grid on all panels has spacing 1 mm).

A: Fragments of bleached chondrules with chondrule rims;

B: Pyroxene chondrules with bleached margins;

C: Fragment of white pocket;

D: Completely bleached chondrules.