TERRESTRIAL AGE SURVEY OF ANTARCTIC METEORITES. K. C. Welten[1], K. Nishiizumi[1] and M. W. Caffee[2]. [1]Space Sciences Laboratory, University of California, Berkeley, CA 94720, USA (E-mail: kcwelten@berkeley.edu), [2]Department of Physics, Purdue University, West Lafayette, IN 47907, USA.

Introduction: Terrestrial ages of Antarctic meteorites provide information on meteorite accumulation mechanisms, pairing, mean survival lifetimes and meteorite influx rates. A timely survey of terrestrial ages of meteorites from various Antarctic ice fields may also provide guidance for the planning and prioritization of future ANSMET (Antarctic Search for Meteorites) field activities. We have begun a systematic survey of terrestrial ages of Antarctic meteorites, based on cosmogenic ^{36}Cl in the metal fraction. The first results (prior to final publication) have been published in the Antarctic Meteorite Newsletter [1].

Method: The determination of terrestrial ages using ^{36}Cl (half-life = 3.01x10^5 yr) is a long-term ongoing project [2]. Carbon-14 is also used to determine terrestrial ages but is extant in only 30-50% of the Antarctic meteorites. The detection limit of ^{14}C corresponds to a terrestrial age of ~35 kyr, so the longer half-life of ^{36}Cl makes it a superb analytical tool for meteorites having terrestrial ages of 35 kyr to ~3 Myr. For more than 90% of ordinary chondrites, measurement of ^{36}Cl suffices to ascertain terrestrial ages. The ^{36}Cl terrestrial age, T_{terr} is calculated by the following equation;

$$T_{terr} = \frac{1}{\lambda} \ln\left(\frac{A_0}{A}\right)$$

where, λ is the ^{36}Cl decay constant, A_o is the ^{36}Cl saturation value, and A is the observed ^{36}Cl activity in the metal phase. The saturation value for small irons and the metal phase of ordinary chondrites is 22.1±2.8 (±2σ) dpm/kg metal [3].

Experimental: We selected ~300 ordinary chondrites from the ANSMET collections. We crush 2-3 g of each meteorite, separate the metal, purifying it with 0.2N HCl and concentrated HF to dissolve attached troilite and silicates, respectively. The purified metal is dissolved along with 1-2 mg of Be, Al, Ca, and 3-5 mg of Cl carrier. After dissolution of the metal, we take small aliquots for chemical analysis by atomic absorption spectrometry. From the remaining solution we separate the Cl as AgCl and purify the AgCl for analysis of ^{36}Cl by accelerator mass spectrometry (AMS) at Purdue University. To date we have processed ~190 meteorites and measured ^{36}Cl in 150 samples; 40-50 additional samples will be measured in the next few months. The non-magnetic fractions are available for noble gas analysis, ^{14}C measurements, and other studies.

^{36}Cl results: The measured ^{36}Cl concentrations range from 1.2 to 25.5 dpm/kg (Fig. 1). Of the 150 samples analyzed so far, about 80 show ^{36}Cl concentrations >20 dpm/kg, i.e. overlapping the activity measured in recent ordinary chondrite falls. For these, additional analyses of ^{41}Ca and/or ^{14}C can provide more precise terrestrial ages.

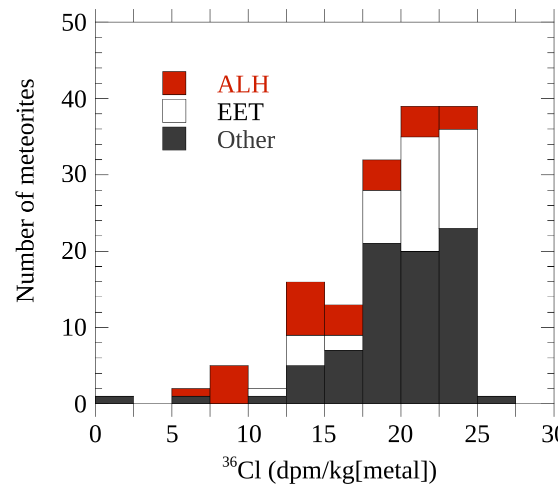


Fig. 1 Histogram of ^{36}Cl concentrations in the purified metal fraction of 150 Antarctic meteorites.

The ^{36}Cl concentrations <20 dpm/kg correspond to terrestrial ages ranging from ~50 kyr up to ~1.25 Myr (Fig. 2). Only 8 meteorites show terrestrial ages >300 kyr and of those eight, six are from the Allan Hills ice fields, which is known to contain old meteorites [2]. The oldest meteorite (1.25 Myr) is from the MacAlpine Hills stranding area, which is within ~30 km from the Lewis Cliff area, where a ~2 Myr old meteorite was found [4].

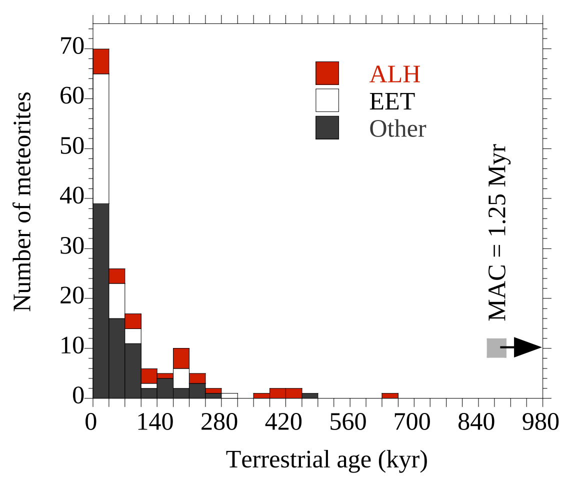
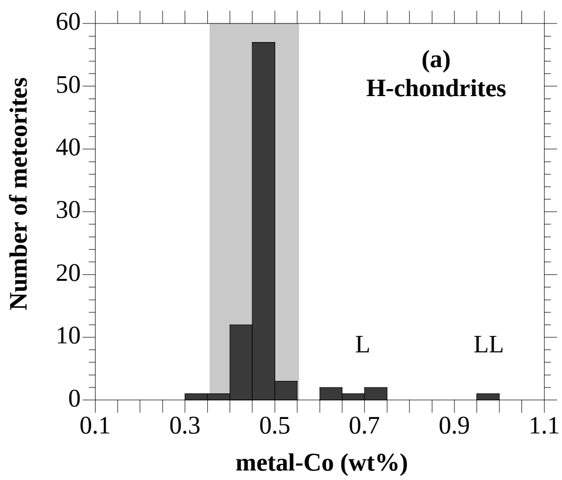


Fig. 2. Histogram of ^{36}Cl-derived terrestrial ages of 150 Antarctic meteorites.

Metal composition: We routinely measure the concentration of Mg, Fe, Ni and Co in the metal fraction of chondrites. The concentration of Mg is a measure of the amount of silicate contamination, which is generally <0.5 wt%. The concentrations of Ni and Co are functions of the chondrite type, increasing from H to L to LL chondrites [5,6]. Metal-Ni contents typically range from 8-10 wt% in H-, 12-18 wt% in L- and 20-50 wt% in LL-chondrites, while metal-Co contents range from 0.40-0.55 wt% in H-, 0.6-0.8 wt% in L- and 0.9-2.5 wt% in LL-chondrites. Figure 3 shows the measured Co concentrations in the metal fraction of 80 meteorites classified as H-chondrite (a) and 87 classified as L-chondrite (b). Of the 80 H-chondrites, only 6 show compositions typical of L- or LL-chondrites. However, of the 87 L-chondrites, more than 20 show metal compositions typical for H-chondrites, while three show compositions typical for LL-chondrites. Based on the bulk metal contents and the measured Ni and Co concentrations in the metal we thus identified more than 30 Antarctic chondrites that may need further petrologic examination to verify the initial classification (e.g. Fig. 3).



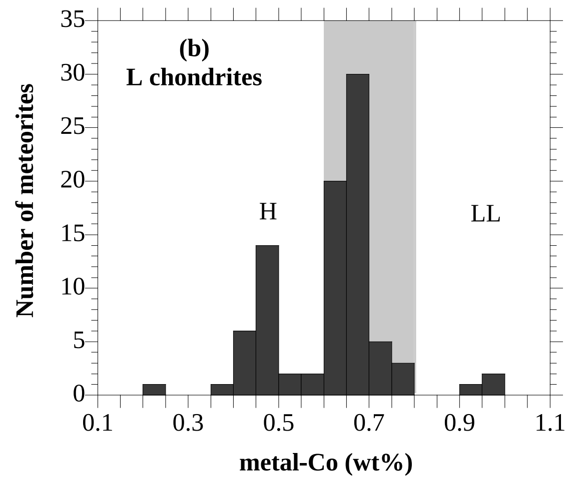


Fig. 3. Histogram of metal-Co contents of Antarctic meteorites classified as H-chondrite (a) and L-chondrite (b). The shaded area represents the range of Co concentrations expected for H- and L-chondrites.

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