INTRODUCTION:
Terrestrial ages of Antarctic meteorites provide information on the long-term stability of the blue ice areas (BIA’s) on which most of these meteorites are found [1]. In addition, they provide information on the lifetime of meteorites on the ice, where they are subject to chemical and physical weathering processes. Previous studies of hot desert meteorites found evidence that achondrites show longer terrestrial ages (up to ~600 kyr) than ordinary chondrites, which are generally younger than 50 kyr. A possible explanation is that chemical weathering of ordinary chondrites is faster than for achondrites, since the former contain significantly more metal, which is rapidly oxidized and may lead to fracturing and decomposition of the chondrite. This difference in terrestrial age between chondrites and achondrites has not been observed for Antarctic meteorites, although the number of terrestrial ages for Antarctic achondrites is rather limited [e.g., 2]. We have measured concentrations of the cosmogenic radionuclides $^{10}$Be (half-life = 1.36 Myr), $^{26}$Al (0.705 Myr) and $^{36}$Cl (0.301 Myr) in 106 Antarctic HED achondrites, including 45 diogenites, 35 howardites and 26 eucrites. Based on these results we determined the terrestrial ages and identified paired fragments of a single fall. This is especially challenging for howardites and polymict diogenite or eucrite breccias, which sometimes show a wide range in compositions. The results for two howardite pairing groups from Grosvenor Mountains (GRO) and Pecora Escarpment (PCA) have been presented in detail before [3-4]. In this work we present recent measurements of HED samples from other ice fields, including Elephant Moraine (EET), Larkman Nunatak (LAR), Miller Range (MIL) and Queen Alexandra Range (QUE).

EXPERIMENTAL PROCEDURES:
We dissolved bulk samples of 50-100 mg in HF/HNO$_3$. After dissolution, small aliquots of the dissolved samples were taken for chemical analysis. We separated Be, Al and Cl and measured the radionuclide concentrations by accelerator mass spectrometry at Purdue’s PRIME Lab [5].

RESULTS:
The measured $^{36}$Cl concentrations in most of the HED samples range from 0.8 dpm/kg to 20 dpm/kg. These variations are partly due to variations in the main target elements for $^{36}$Cl production, which include Fe, Mn, Ti, Ca and K. Adopting relative $^{36}$Cl production rates (compared to Fe) of 1.2 for Mn, 3 for Ti, 8 for Ca and 16 for K, we normalized the measured $^{36}$Cl concentrations to the effective Fe concentration, $\Phi = [Fe + 1.2^{*}Mn + 3^{*}Ti + 8^{*}Ca + 16^{*}K]$. This yields $^{36}$Cl concentrations of 1.1 to 30 dpm/kg[Fe*] for the Antarctic HED meteorites, compared to an average saturation value of 23 ± 3 dpm/kg[Fe*].

Elephant Moraine. The normalized $^{36}$Cl concentrations in 11 HED meteorites from EET range from 15-25 dpm/kg[Fe*], corresponding to terrestrial ages up to ~200 kyr. Based on the combined radionuclide data, we identified six different falls. The radionuclide concentrations in the EET howardites confirm the pairing assignments proposed in [6], including EET 87503/87513 and EET 87509/99400.

Miller Range. The normalized $^{36}$Cl concentrations in 21 HED meteorites from MIL range from 10-27 dpm/kg[Fe*], yielding terrestrial ages up to ~350 kyr. Based on the radionuclide data, we identified two diogenite pairing groups of at least 3 members and one eucrite pairing group. Altogether, the 21 HED meteorites represent 4 different diogenite falls, 2 howardite falls and 5 eucrite falls.

Queen Alexandra Range. The normalized $^{36}$Cl concentrations in 7 HED meteorites from QUE range from 12-23 dpm/kg[Fe*], corresponding to terrestrial ages up to ~300 kyr. The meteorites represent 4 different falls.

Larkman Nunatak. The normalized $^{36}$Cl concentrations in 7 HED meteorites from LAR range from 1.1-17.5 dpm/kg[Fe*], corresponding to terrestrial ages of 100 kyr to 1.3 Myr. The exceptionally long terrestrial age for LAR 12326 is supported by the low concentrations of $^{10}$Be (11.6 ± 0.1 dpm/kg) and $^{26}$Al (21.5 ± 0.3 dpm/kg). Interestingly, LAR 12326 is a 10.5 kg howardite almost completely covered with fusion crust.

CONCLUSION:
Cosmogenic radionuclides in 106 Antarctic HED meteorites indicate they represent 65-70 different falls. The terrestrial ages of most HED meteorites are comparable to those of ordinary chondrites, i.e. <400 kyr, with most ages <150 kyr. The HED meteorites from LAR are the exception, as their terrestrial ages peak between 200-400 kyr, with one exceptionally old age of ~1.3 Myr for LAR 12326. Terrestrial ages of only a few LAR chondrites have been measured, indicating ages <100 kyr. Although this may indicate that achondrites at LAR are systematically older than ordinary chondrites, more terrestrial age data of both chondrites and achondrites at LAR are needed to verify whether this hypothesis holds up, or whether LAR 12326 simply represents an outlier.

REFERENCES: