STATISTICAL SIMILARITIES AND DIFFERENCES BETWEEN METEORITE FALLS, FINDS AND ANTARCTIC METEORITES PHYSICAL PROPERTIES. D. R. Ostrowski[1], [1]Bay Area Environmental Research Institute, Ames Research Center, Moffett Field, CA, USA, [2]NASA Ames Research Center, Moffett Field, CA, USA. E-mail: daniel.r.ostrowski@nasa,gov..

Introduction: Terrestrial weathering plays a significant role in the chemical and physical determinations of the meteorite current condition and evolution. The chemical alterations come in multiple forms at different rates depending where in the world the meteorite is found. These different chemical processes and their effect on the different meteorite types are well described in Bland et al. 2006 [1].

Density and porosity are two of the most studied physical properties of meteorites. These properties are not immune from the effects of terrestrial weather, with oxidation playing a large role. Oxidation of meteoritic metals leads to substantial volume expansion [2]. Also, an increase in the amount of clay minerals can occur and causes alteration in the structure of the clay minerals [3]. Bulk and grain density are affected in different ways. The addition of less dense minerals will decrease bulk density, but these minerals also have expanded volume filling poor space causing grain density to decrease [4]. In the comparison of meteorite porosity for *falls* to *finds*, the grain volume expansion caused by oxidation causes meteorite *finds* tends to be lower [5]. This is clearly seen in the ordinary chondrites with the *falls* having an average porosity of 7.4±5.3% and *finds* average porosity being 4.4±5.1% [6]. Antarctic meteorite *finds* are different from that of *falls* and other *finds*. Antarctic weather effects reduce the bulk density and leaves the grain density similar to that of meteorite *fall* densities, thus the porosity will be higher than compared to non-Antarctic *finds* [6].

Terrestrial weathering does have an effect on other properties such as thermal and strength. To what extent is there statistical similarities or differences between meteorite *falls* and *finds*. If finds and Antarctic meteorites are similar to *falls* than they can be used to augment the limited data set to imply the physical properties of asteroids. This is important since many of the physical property measurements can be destructive.

Statistical Analysis: Physical properties that are studied are compression and tensile strength, acoustic velocity, thermal conductivity, and heat capacity. Thermal properties are at 300K. Directly measured values are combined with data from neoproperties.arc.nasa.gov for the statistical analysis of three different groups of meteorites. Meteorite *falls*, *finds*, and Antarctic *finds* are compared to each other to understand the populations differences. Among these three population sets compared are all stony meteorite classifications combine and just the ordinary chondrites.

Type of statistical test used are two sample t-test with unequal variances and single factor ANOVA to determine similarity of all three populations. For all test alpha is set to 0.05.

Results: Acoustic velocity shows (fig 1) that across the board that all types of meteorite *finds* are different than the measured values of the *falls* population. These results are confirmed by the results in table 1. Antarctic *finds* and other *finds* show a different result where in the all-meteorite set they are the same, but the ordinary chondrite subset is statistically different.

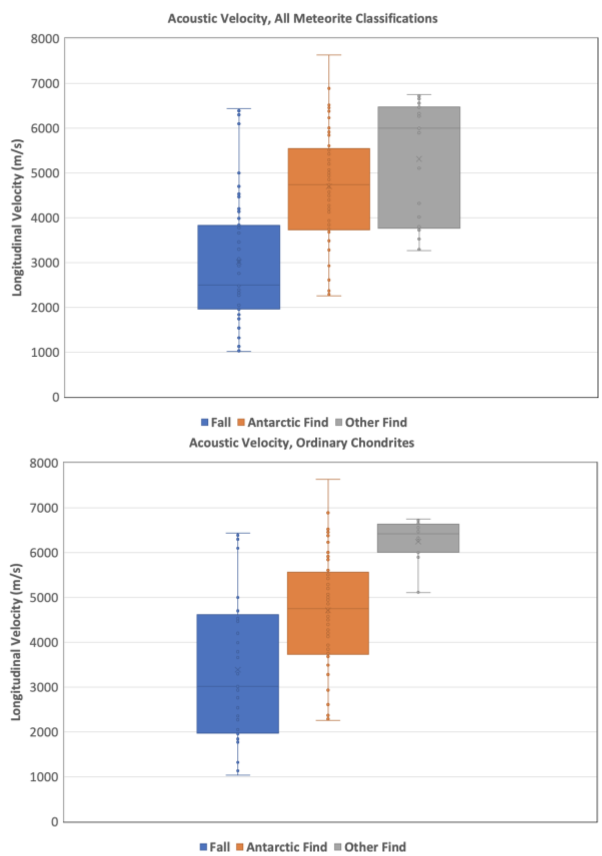

Figure 1: *Box plot for the range in longitudinal velocity in all meteorite classifications (A) and the subset of ordinary chondrites (B). Significant overlap in the range of values for each of the three sets, but limited overlap in interquartile range indicates populations are different.*

Table 1: Statistical test P values.

	t-Test			Anova
Property	Fall vs Antarctic	Fall vs Finds	Antarctic vs Finds	Fall vs Antarctic vs Find
Longitudinal Velocity	$P=2x10^{-12}$	$P=6x^{10-9}$	P=0.051	$P=3x10^{-15}$
	$P=3x10^{-5}$	$P=5x10^{-11}$	$P=3x10^{-6}$	$P=1x10^{-10}$
Shear Velocity	$P=8x10^{-14}$	$P=1x10^{-9}$	P=0.234	$P=7x10^{-17}$
	$P=3x10^{-5}$	$P=4x10^{-9}$	$P=6x10^{-5}$	$P=8x10^{-10}$
Compression Strength*	NA	P=0.030	NA	NA
	NA	P=0.119	NA	NA
Tensile Strength**	NA	P=0.013	NA	NA
	NA	P=0.051	NA	NA
Thermal Conductivity	P=0.679	P=0.216	P=0.047	P=0.115
	P=0.596	P=0.015	$P=3x10^{-4}$	P=0.006
Heat Capacity	P=0.761	P=0.177	P=0.120	P=0.560

*Antarctic meteorites only have two measured values
**Antarctic meteorites only have one measured value
***Blue = data sets are similar, Red = data sets are different

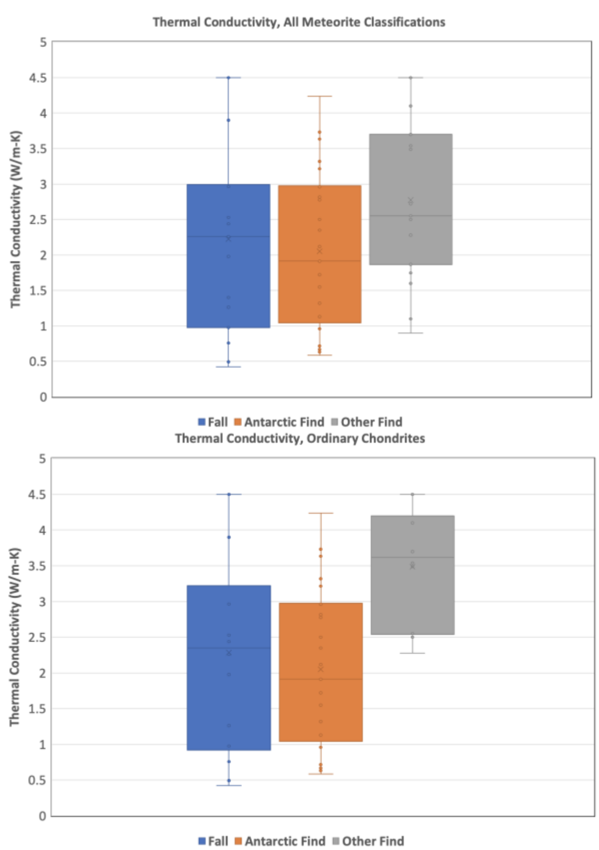

Figure 2: *Box plot for the range in thermal conductivity in all meteorite classifications (A) and the subset of ordinary chondrites (B). Significant overlap in the range of values interquartile range indicates similar populations for falls and Antarctic meteorites.*

Thermal properties have a different relationship than mechanical properties. Thermal conductivity has mixed results (fig 2) of which *falls* and Antarctic *finds* in both the all-meteorite set and ordinary chondrite subset are similar. Whereas meteorite *finds* are statistically different from both the *falls* and Antarctic *finds* among the ordinary chondrites. As for heat capacity, all meteorites studied are ordinary chondrites and all three populations are statistically similar.

Conclusion: Terrestrial and Antarctic weathered meteorites have mixed results if they are viable to use in addition of *falls* to relate mechanical properties to asteroids. Acoustic velocity suggest it is not possible, but compression and tensile strength of ordinary chondrites finds implies that it is possible. For thermal properties, *falls* and Antarctic meteorite *finds* have the same data values. This implies that Antarctic weathering has minimal to no effect on a meteorite's thermal properties.

Acknowledgments: This work is funded by NASA's Planetary Defense Coordination Office (PDCO) and is conducted under the Asteroid Threat Assessment Project as NASA Ames Research Center. The Antarctic meteorites used for study are on loan from the Lyndon B. Johnson Space Center's Astromaterials Sample Control Center.

References: [1] Bland P. A. et al. (2006) *Meteorites and the Early Solar System II*, 853-867. [2] Buddhue J. D. (1957) *The Oxidation and Weathering of Meteorites*. Univ. of New Mexico, Albuquerque. [3] Bland P. A. et al. (1996) *Geochim. Cosmochim. Acta,* 60, 2053-2059. [4] Consolmagno G. J. and Britt D. T. (1998) *Meteoritics & Planet. Sci.*, 33, 1231-1241. [5] Britt D. T. and Consolmagno G. J. (2003) *Meteoritics & Planet. Sci.*, 38, 1161-1180. [6] Consolmagno G. J. et al. (2008) *Chemie der Erde*, 68, 1-29.