Further Development of the Robust Antarctic Volcanic Record using Tephra Layers from the WAIS Divide WDC06A Ice Core

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The WAIS Divide ice core WDC06A may offer one of richest tephra records ever recognized in an ice core, rivaling the Byrd ice cores, which was estimated by Gow and Williamson (1971) to contain around 2000 individual tephra falls. To date, several hundred "dust bands" have been visually recognized in WDC06A (Fig. 1) through careful observation by on-site core handlers and subsequent core processing at the National Ice Core Laboratory (NICL). The record of the depths of the layers in Fig. 1 was provided by A. Orsi, based on compilations from a large group of core handlers and processers.

Initial sampling included collection of 33 "dust bands" from the WDC06A ice core, done at NICL (Fig. 1). A subset of these has been analyzed, and we hope to have the remainder analyzed in time for this meeting. Most of the "dust bands" have proved to be tephra layers (Table 1). However, three of the samples analyzed are composed of a mixture of volcanic ash and other silicate material, such as quartz and feldspar. The composition of the ash fragments in these samples is variable, and the layers are interpreted to be windblown debris. Some of these samples are from parts of the core that were described as "cloudy" rather than representing a distinct band. The tephra layers analyzed so far in the WDC06A core contain abundant material and yielded robust chemical fingerprints using major geochemical composition when analyzed by electron microprobe. These fingerprints have allowed a number of correlations to be made between WDC06A tephra and tephra layers recognized in Siple Dome (SDMA and SDMB), Taylor Dome, and Byrd ice cores, the Mt. Moulton tephra-bearing blue ice area, and source volcanoes. These correlations are summarized in Table 1. Age correlations between the WDC06A-06 timescale and timescales from other sources agree well. Two instances of ambiguous correlations have been observed (see starred samples in Table 1), and we hope that future trace element determinations using LA-ICPMS method on single tephra particles in question will be able to resolve these ambiguities. A high degree of correspondence is observed between tephra layers

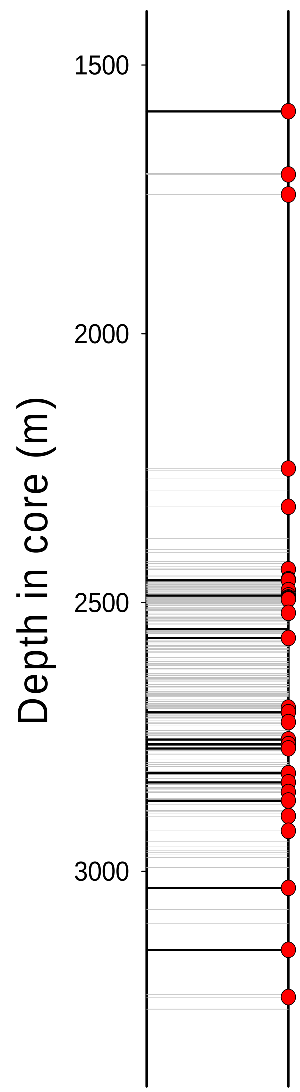

Figure 1. Tephra detected in the WDC06A ice core . Dark bars represent prominent layers, grey bars are less prominent layers and cloudy horizons. Circles on the right-hand axis show sampling depths.

observed in the Siple Dome SMDA ice core and those observed in WDC06A, although the latter record appears to contain many more layers.

A very prominent tephra layer located at a depth of 2569.205 m in the WDC06A ice core was presented at the WAIS Divide 2011 meeting as being the result of a briefly emergent subglacial volcanic eruption. We continue to favor this interpretation, and have worked with J. Behrendt to identify a source (possibly "anomaly N" from Behrendt et al., 2004). Detailed particle morphology work done in association with K. Cashman will help strengthen the interpretation of partially subglacial origin. Furthermore, the relatively large size and abundance and composition of the feldspar in this tephra layer may allow it to be the first-ever directly dated ice core tephra layer using $^{40}Ar/^{39}Ar$ method.

Table 1. WDC06A layers analyzed to date. Ages of Siple Dome (SDMA) horizons from Taylor et al., 2004 and Brook et al., 2005; SDMB from K. Taylor, pers. comm.; Taylor Dome from Hawley et al, 2002. Ages of source eruptions are made using the $^{40}Ar/^{39}Ar$ technique, with original ages presented in Wilch et al., 1999 and Dunbar et al., 2008.

WAIS Divide top depth (m)	WDC06A-6 timescale age (yrs before 1950)	Correlation	Correlative age	Source comments
190.37	702	WDC05-190.810 SDMB-97.2 Taylor Dome 79.155	702 705-710 675±25	Pleaides, East Antarctica
1589.187	8174	SDMA9002 Byrd Core 788m. Source eruption	8166 8200±5400	Mt. Takahe
1706.775	9204	SDMA9001	9237	South America
2441.95	18306	SDMA5540 Source eruption	18200 18200±5400	Mt. Berlin
2461.88	18940			debris
2491.004	19878			debris
2494.259	19985			debris
2569.205	22472	None found		Subglacial eruption
2707.735	26910	SDMA5630	26520	Mt. Berlin BIT151
2758.15	28356			Mt. Berlin
2767.117*	28602	SDMA5694 Source eruption	28700 27.3±2.3	Mt. Berlin BIT152
2774.876*	28830	SDMA5694 Source eruption	28700 27.3±2.3	Mt. Berlin BIT152
2821.070	30442	None found		Similar to Mt. Berlin
2837.880*	31089	SDMA5874	31480	Mt. Berlin
2856.100*	31856	SDMA5874	31480	Mt. Berlin
2900.67	33635	SDMA5842, 9065	32530	Mt. Berlin
2928.155	34766	None found		Similar to Mt. Berlin
3034.70	39434	None found		Similar to Mt. Berlin
3149.138	45381	None found		Nearby source, unknown