A Revised Age of 7430 ± 250 ^{14}C yrs BP for the Very Large mid-Holocene Explosive H1 Eruption of the Hudson Volcano, Southern Chile

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Abstract. The mid-Holocene H1 explosive eruption of the Hudson volcano (46°S), the largest (≥18km^3) Holocene eruption of any volcano in the Andean Southern Volcanic Zone (SVZ), has previously been dated as 6720 ± 140 (Naranjo and Stern 1998) or 6850 ± 160 ^{14}C yrs BP (Stern 2008) by conventional ^{14}C ages. Seven new AMS ^{14}C ages suggest that the eruption was in fact somewhat older and occurred at 7430 ± 250 ^{14}C yrs BP or 8260 ± 240 cal yrs BP. The age of the tephra produced by this eruption is significant both because of its wide spatial distribution, as well as its distinctive petrochemical characteristics, which make it an important chronological marker for mid-Holocene paleo-climate and archaeological studies in southern Patagonia. Although H1 was the largest, it was only one of more than 45 explosive late-glacial and Holocene eruptions of both the large stratovolcanoes and small monogenetic cones in the southern part of the Andean SVZ as evidenced by tephra preserved in lake sediment cores in the area.

Keywords: Hudson volcano, tephra, Patagonia, Andean volcanism, tephrachronology

1 Introduction

The Hudson volcano, the southernmost volcano in the Andean Southern Volcanic Zone (SVZ; Stern, 1991, 2004, 2008; Naranjo and Stern, 1998; Stern et al., 2007), has had numerous explosive Holocene eruptions, the largest of which (H1; ≥18 km^3) occurred in the mid-Holocene. This eruption produced a distinctive Ti, Nb, and Y-rich grey-green andesitic tephra distributed in a southern direction away from the volcano, with a distal maximum thickness of between 10-20 cm on Tierra del Fuego more than 900 km to the south (Stern, 1991, 2008).

The wide area of deposition of H1 tephra in southern Patagonia makes this tephra an important chronological marker for paleo-climate and archaeological studies (Stern 2008). Auer (1974) termed this Tephra II and suggested an age of between 4480 and 6600 ^{14}C yrs BP. Stern (1991) provided eight new dates for this tephra that implied an age of between 6625 and 6930 ^{14}C yrs BP. Naranjo and Stern (1998) dated the eruption to have occurred at 6720 ± 140 ^{14}C yrs BP based on what they considered to be their best constrained age determination. Subsequently Stern (2008) calculated an age of 6850 ± 160 ^{14}C yrs BP for this eruption based on an average of 17 conventional ^{14}C ages.

The average of seven new Accelerator Mass Spectrometry (AMS) ^{14}C ages (Table 1) suggest a somewhat older age of 7430 ± 250 ^{14}C yrs BP or 8260 ± 240 cal yrs BP for the H1 eruption of the Hudson volcano.

2 Methods, Samples and Results

The samples dated (Table 1) come from both above and below the Hudson H1 tephra in outcrops as well as tephra samples from both lake and marine cores. They include samples from relatively proximal localities near Cochrane within <150 km of the Hudson volcano and much more distal localities far to the south in Magallanes, Tierra del Fuego and Isla de los Estados. Details of the techniques used and materials dated are provided in the cited references from which the dates were obtained. The cal yrs BP ages in Table 1 were all calculated by the "CalPal" online calibration program in order for them to be consistent with each other.

3 Discussion and Conclusions

The seven new AMS ages for the H1 tephra range from 7043 to 7775 ^{14}C yrs BP and average 7430 ± 250 ^{14}C yrs BP, or 8260 ± 240 cal yrs BP using the "CalPal" on line calibration program. No explanation is offered for the difference with the previously published average of 6850 ± 160 ^{14}C yrs BP for seventeen conventional ^{14}C ages (Stern, 2008) beyond the possibility that the AMS technique is more accurate and that the smaller samples dated might have less contamination by young root material.

The Hudson H1 eruption is only one of a number of other large Holocene explosive eruptions of volcanoes in the southern part of the Andean SVZ. These include a mid-Holocene explosive eruption of Mentolat volcano (MEN1) at approximately 6960 ± 60 ^{14}C yrs BP (7800 +/- 70 cal yrs BP; Naranjo and Stern, 2004) and two younger large eruptions of Hudson (H2 at ~3600 ^{14}C yrs BP and in August of 1991; Naranjo and Stern, 1998). Bog profiles indicate at least 7 other explosive eruptions of Hudson after H1, and evidence for two older eruptions are preserved as tephra in lake sediments on peninsula Taitao

west of the volcano (Lumley et al., 1993). Preliminary study of tephra in lake cores near Coihaique also preserve tephra that confirm more than one explosive eruption of the Hudson volcano prior to H1, as well as tephra from more than 45 other late-glacial and Holocene eruptions of both the large stratovolcanoes in the southern SVZ and the small monogenetic basaltic cones in the southern part of the Liquiñe-Ofqui Fault zone. The data imply the potential for significant volcanic risk for the growing population in the Coihaique area.

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Table 1. New AMS ^{14}C age determinations for the Hudson H1 tephra.

General location	Core location	Depth cm	Lab #	^{14}C yrs BP	cal yrs BP	References
Tierra del Fuego	Las Cotorras bog	470-475	AA62823	>7043 +/- 47	>7884 +/- 47	Borromeni et al., 2010
Cochrane	Roadcut outcrop			>7165 +/- 60	>7995 +/- 46	Holz 2011*
Magallanes	Strait of Magellan	990	OS72978	>7480 +/- 55	>8293 +/- 65	Aracena et al., In press
Cochrane	Augusta lake			>7485 +/- 60	>8296 +/- 67	Moreno & Villa Martinez, 2010*
Isla de los Estados	Laguna Cascadia	387	LuS6935	>7715 +/- 60	>8502 +/- 57	Unkel et al., 2010
Magallanes	Hambre lake	804-806	Keck79260	<7370 +/- 20	<8223 +/- 42	Hermanns & Biester, 2011
Isla de los Estados	Laguna Cascadia	391	LuS6936	<7775 +/- 60	<8545 +/- 64	Unkel et al., 2010
Average				7430 +/- 250	8260 +/- 240	

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