WHAT IS THE REAL ISOTOPIC SIGNATURE OF DUST EMITTED FROM TIERRA DEL FUEGO?

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In their letter to *Nature Geosci*. **2,** 281–285; 2009, Sugden and others suggested an on/off switch mechanism that could explain the 20 times increase of dust deposition in Antarctica during the Last Glacial Maximum (LGM), as compared to present day. This suggested switch resides in Patagonian pro-glacial lakes; when glaciers retreat sediments are deposited in the lakes and dust emission ceased in opposition to cold periods, when glacial pour out sediments to the outwash plain, then increasing dust emission. The on/off switch mechanism proposed is supported on age analyses and strontium (Sr) and neodymium (Nd) isotope ratios of ancient lacustrine samples from the Magellan Strait (MS) and from the North Patagonian icefield (NPI). The lacustrine sediments were used as representative of sediments that were disgorged to the outwash plain during the LGM. We argue on the type of samples used to characterize the possible Patagonian outwash sediments deflated during the LGM and accordingly, on the interpretation of the source of this dust. Also it is worthy to consider the possible decline of the Patagonian proximal (MS) outwash dust emission due to permafrost occurrence during cold periods.

Modern sediments are deflated from the Patagonian surface mainly from widespread ephemeral lakes[1] (see auxiliary materials), which are sporadically refilled with sediments supplied from the surrounding areas mainly through water runoff. Figure 1, shows that the mean isotopic composition of dry lake sediments (collected from the ancient outwash plain in the San Sebastian Bay area) and dust collected at Rio Grande (Table 1, auxiliary materials) are significantly different compared to MS samples and very similar to sediments representing the Fuegian continental shelf[2] and the glacial sediments recovered from the north Scotian Sea (Walter et a., 2000). Similar to modern dust released from continental Patagonia (north of ~52°S), modern data from Tierra del

Fuego could also be explained by a mixing between Jurassic rhyolites and Quaternary volcanic rocks[3] (Fig. 1). On the contrary, the samples used by these authors seem to characterize discrete sources. The isotopic composition of most samples from the MS plots mostly within the compositional field corresponding to the Jurassic rhyolites that outcrop all close along the Fuegian Cordillera[3] (Fig. 1). In the case of NPI samples, their compositions are similar to the local outcropping Paleozoic plutonic and metasedimentary rocks[4] (not shown in Fig. 1). Nevertheless, directly to the W of the NPI, the isotopic composition of Pliocene/Pleistocene Chilean trench sediments (mean $^{87}Sr/^{86}Sr$=0.707 and $\delta_{Nd}(0)$=-2.1) indicate a variable contribution from other rocks outcropping in the area (e.g., Quaternary volcanic rocks[4]).

Why MS and NPI samples are different from modern Patagonian dust? A possible interpretation is that the MS and NPI samples were collected far behind from the LGM outwash plain and close to the moraines and glacier headwaters and probably they were impeded to be mixed with rocks debris introduced from lower glacier basins and/or isolated from mixing with Quaternary ash fall. For case, sample #10 (19,547-19,807 Cal. yr)(see Table 1 in the Sugden and others` paper) was collected ~90 km south, behind the glacier lobe. This sample represents Stage C when MS glaciers discharged directly onto the outwash plain. Possibly, during this stage ice mass isolate sediments from direct ash falls and sediments preserved a Jurassic rhyolites` signature (Fig. 1). During Stages D and E, when glaciers terminated directly onto lakes, sediments were deposited under sub-aqueous conditions and the efficiency of mixing with discrete ash fall events could be less effective. Conversely, sample #5 (14,348-15,507 Cal. yr) was deposited and probably contaminated by the Reclùs ash fall event (c. 15.3 ka)[5], following a more modern Tierra del Fuego signature (Fig. 1). Other important ash fall events occurred in the region during the Pleistocene; Burney volcano (c. 45 ka)[6] and Hudson volcano (active since 1.0 Ma)[7,8] eruptions. This could suggest that the modern Tierra del Fuego isotopic signature (typically associated with ash-fall) was active also during older glacial periods.

A second important issue is the probable control of dust emission exerted by the presence of permafrost conditions during glacial times. Fossil patterned grounds and other frozen ground related cryoforms were found in many periglacial areas of southern Patagonia (e.g., ~100 km to the E of Bahìa Inùtil)[9,10]. Based on stratigraphic analysis these cryogenic features correspond to most of glacial stages since the early Pleistocene up to the LGM. Probably, the most affected area were the glacier proximal more humid outwash plains, suggesting that the sources of dust during cold periods could be restricted to the distal continental shelf. However, as suggested by Sugden and others (and cites therein), this possibility is less probable as Antarctic dust flux declined before sea level rose at the end of the LGM.

Noticeably, age control of sediments representing potential dust source areas are important in order to be compared with the marine and ice core dust records, but could not assure the unbiased nature of the samples that ultimately are deflated from continents and, we need more studies in order to elucidate if dust from the Patagonian outwash plains was effectively emitted during glacial periods.

Captions.

Figure 1. **Mean isotopic composition of modern sediments from Tierra del Fuego.** They are compared to the mean and the individual isotopic composition of samples used by Sugden and others to characterize Patagonian outwash plain sediments during the LGM. Shadowed areas represent the isotopic composition of the most representative Patagonian rocks (adapted from Gaiero et al., 2007).

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