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Letter to the Editor

Comment on: Cosmogenic nuclide chronology of pre-last glacial maximum moraines at Lago Buenos Aires, 46°S, Argentina (Quaternary Research 63/3, 2005, 301–315)

Using absolute dating methods, Kaplan et al. (2005) have attempted to determine the age of 19 moraines of the Buenos Aires glacier. The moraines have been grouped into four complexes: Fenix, Moreno, Deseado and Telken. The following critique refers mainly to the chronological classification of the three Moreno moraines, the five Fenix moraines, and the beginning of the final deglaciation.

Regarding the age of the three Moreno moraines

According to Kaplan et al., the Moreno I and II moraines originated between 190,000 and 109,000 yr ago and the Moreno III moraine is reported to be significantly older and presumably marks a retreat position of the Deseado I advance. My proposition is: all three Moreno moraines originated during the last glacial maximum (LGM) (ca. 22,000–18,000 yr ago).

Using the Moreno III moraine age as an example, it shall be demonstrated that the cosmogenic nuclide chronology as applied by Kaplan et al. is speculative.

(1) "For Moreno III, the boulder ages determined with the local erosion rate range from ca. 648,000 to 119,000 yr" (pp. 308–309).
(2) "The minimum moraine age for Moreno III, obtained from the oldest exposure age with no erosion …, may be 315,000±41,000 yr" (p. 311).
(3) "The two oldest zero erosion Moreno III ages are more than 125,000 yr older than any boulder from the younger Moreno I and II moraines …" (p. 311).
(4) "If the oldest boulders are from a prior glaciation, then Moreno III would be part of the same glaciation as the younger Moreno I and II deposits" (p. 311).
(5) "The ages of the three oldest erratics on Moreno III and Deseado I may suggest that the glaciation that they reflect was at least two glacial cycles (325,000–190,000 yr ago) before Moreno II (Fig. 7)" (p. 312).

I will demonstrate that all three Moreno moraines belong to the LGM. Since there is only one outwash plain in front of the M I, II and III moraines (Fig. 1, this comment), they must have been accumulated during the same glaciation. Therefore, the actual ages of these moraines should be checked.

The Moreno moraines are supposedly older than 109,000 yr. This is explained as follows: "Outwash graded to the Moreno I moraine forms a discontinuous terrace at about 460–440 masl along the south side of the Rio Deseado valley (Figs. 2 and 3A). This terrace is buried by the Cerro Volcán lava flow, and thus the Moreno system is older than the 109,000-yr-old lava (Singer et al., 2004)." (p. 302). Since the Cerro Volcán basalt extends into the modern valley floor of Río Deseado – this is visible in Figure 1 (this comment) – the alluvial deposits must also be >109,000 yr old. Apparently, the authors did not distinguish basalt lava flows in situ from basalts moved by talus and frost creep or fluvial processes. As field investigations have shown, the basalts that cover the terraces of the Río Deseado or respectively parts of the eastern outwash plain are redeposited basalts and thus cannot be used to estimate the age of the Moreno moraines. Nevertheless, the age of the Moreno I and II moraines is determined as follows: "Two approaches, maximum boulder ages assuming no erosion, and the average age of all boulders and an erosion rate of 1.4 mm/10^3 yr, both yield a common estimate age of 150,000–140,000 yr for the two moraines" (p. 301). However, the morphological characteristics do not support a "calculated" age of the Moreno I and II moraines of 150,000–140,000 yr: "The Moreno moraines more commonly have identifiable closed depressions (Fig. 3B; e.g., kettle holes), in contrast to older moraines" (p. 302). Due to the low temperature (8.3°C mean annual temperature in Perito Moreno) and high wind strength, the talus, frost-creep, and aeolian processes in this area are intense. Consequently the preservation of kettle holes during the past 140,000 yr can be excluded. Further morphological features are as well in contradiction to this age: both moraine ridges are completely preserved and they are the "morphologically most youthful moraines" (Singer et al., 2004, p. 447). Thus, the Moreno moraines must be considerably younger and their LGM age is self-evident.

Regarding the age of the five Fenix moraines

"New cosmogenic surface exposure ages of moraine boulders on the Fenix I, II, III, and V moraines combined with the ^{14}C ages of the varved sediment (Kaplan et al., 2004) indicate that at least five ice advances between ca. 23 and 16 ka occurred during the LGM …" (Singer et al., 2004, p. 448).

My proposition is: the Fenix moraines originated during the late glacial interval and can be assigned to three advances between 15,000 and 10,000 ^{14}C yr BP (Fig. 1). Singer et al. (2004, p. 437) describe the Fenix moraines and the adjacent outwash plains as follows: "The intervening outwash plains between these moraines consist of coarse gravel with clear, braided stream networks (Fig. 2)". The authors did not consider

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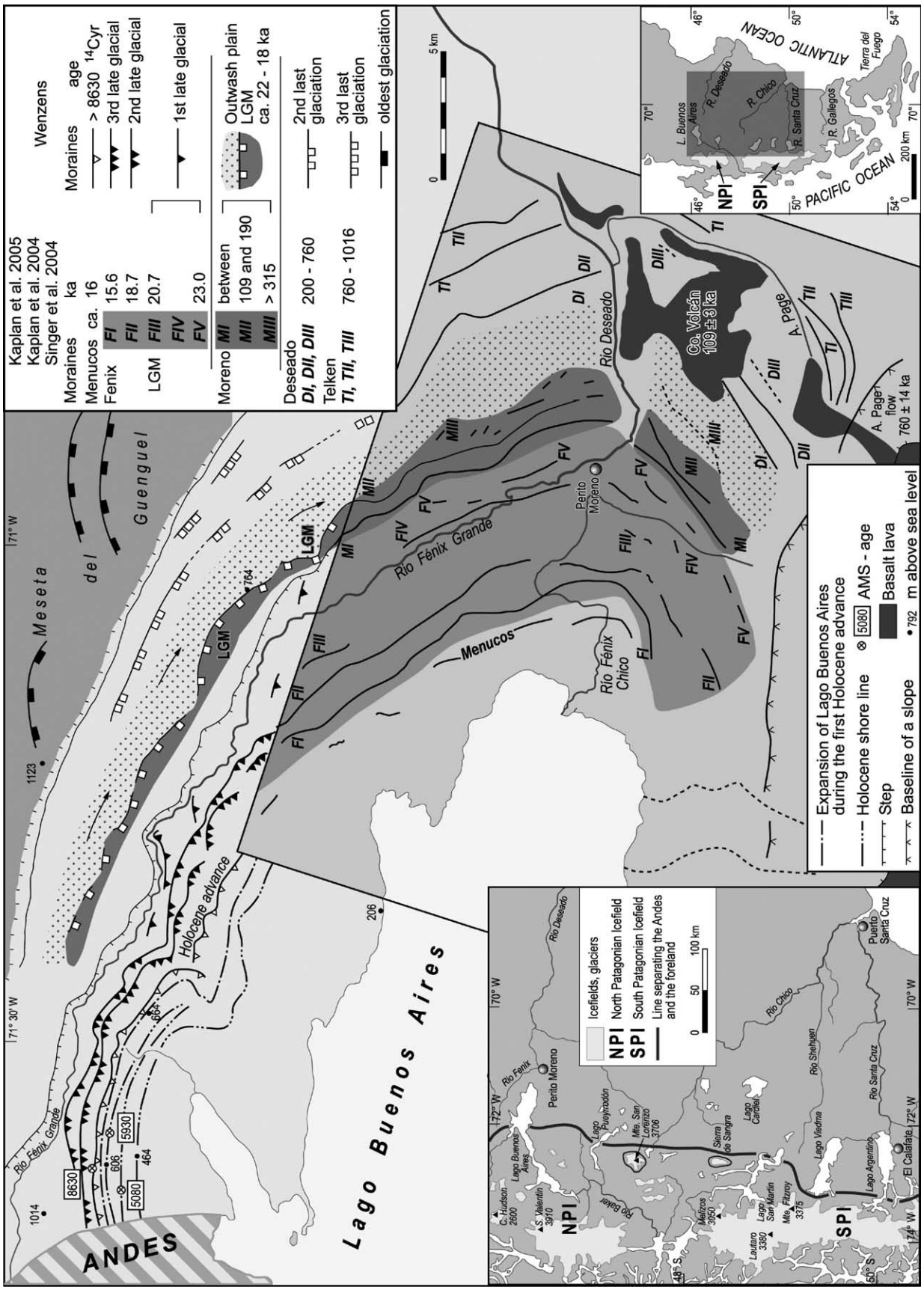

Fig. 1. Ages of the moraine systems north and east of Lago Buenos Aires after Kaplan et al. (2004, Fig. 2) and Wenzens (this comment).

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essential morphological facts of this region. Between the Fenix II moraine and the step of the Moreno I moraine extends the flat valley floor of the Río Fenix Grande. This river is a broad meltwater stream that has its origin in the Cordilleran crest, with altitudes above 2100 masl. This means that there is no outwash plain east of the Fenix II moraine. The "coarse gravel with the clear braided stream networks" (Singer et al., 2004, p. 437) was accumulated by Río Fenix Grande and shows an unambiguous valley-floor topography. So, the Fenix moraines are lacking a typical feature of the LGM moraines in Patagonia.

During the younger late glacial epoch and the Holocene, the moraines of the first late glacial advance were dissected by Río Fenix Grande. Kaplan et al. (2004, Fig. 2) assigned these erosional remnants to three different advances (Fenix III–V) (Fig. 1). Three late glacial advances, of which the youngest occurred during the Younger Dryas stade, have been described by Wenzens (1999) in the area between Lago Argentino and Lago Viedma, by Strelin and Malagnino (2000) in the region of Lago Argentino, by Wenzens (2002) in the region of Lago San Martín, and by Wenzens (2005) in the area of Lago Pueyrredón and south of Monte San Lorenzo (3706 masl) (Fig. 1). Yet, in the area of Lago Buenos Aires, Kaplan et al. (2004) and Singer et al. (2004) have only assigned a single moraine, the Menucos moraine, to the late glacial period. "The Menucos moraine represents a readvance subsequent to 15.8 ka" (Singer et al., 2004, p. 437). Although this moraine may also be 8630 ^{14}C yr BP old, the authors assume an age of ca. 16,000 yr and justify this as follows: "Southwest of the study area, Mercer (1976) obtained a ^{14}C age of 11.2±0.2 ^{14}C yr (13.2 ka), which provides a minimum age for the opening of the Río Baker outlet to the Pacific Ocean and ice recession from the Lago Buenos Aires basin and, thus, formation of the Menucos moraine. In any case, deglaciation in the Lago Buenos Aires basin occurred sometime after or ca. 16 ka ..." (Kaplan et al., 2004, p. 319).

High-lying shoreline terraces of Lago Buenos Aires with ages between 8630 and 5930 ^{14}C yr BP, however, contradict an emptying of the lake about 16,000 yr. Around ca. 5930 ^{14}C yr BP, the lake level was still 400 m above the modern level (Fig. 1), which is inconsistent with a fluvial drainage to the Pacific at that time. The following assertion made by Kaplan et al. (2004, p. 319) is also wrong: "The timing of the last Lago Buenos Aires deglaciation is entirely consistent with that of other mid-latitude South American records, indicating that the main transition to the present interglacial climate was apparently under way by or ca. 16 ka (Ariztegui et al., 1997; Denton et al., 1999; Markgraf, 2001)". Ariztegui et al. (1997, p. 336) reported: "Phase 3 (11.4 to 10.2 kyr BP) ... indicates a phase of climate deterioration which is in correspondence with the Younger Dryas (YD) cold interval." Denton et al. (1999) summarized: "... that a late-glacial climate reversal of ≤2–3°C set in close to 12,200 ^{14}C yr BP, after an interval of near-interglacial warmth, and continued into Younger Dryas time." (p. 107). Markgraf did not publish anything concerning the late glacial epoch in 2001.

If assumed that during the past 15,000 yr, largely consistent climatic conditions dominated east of both ice fields (NPI and SPI; Fig. 1, this comment), then there were also 3 late glacial advances in the area of Lago Buenos Aires: the Fenix moraines are assigned to the late glacial epoch and correspondingly the Moreno moraines to the LGM.

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