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LATE GLACIAL ICE RETREAT IN THE SOUTHERNMOST ANDES: SEDIMENTOLOGICAL AND PALYNOLOGICAL IMPLICATIONS

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INTRODUCTION

The late Pleistocene ice retreat show distinct character0istics along the southern Andes between latitudes 40 to 54°S. Between 40 to 47°S the major ice retreat occurred previously to 16000 cal. y. B.P. (e.g. Bennet et al. 2000, Denton et al. 1999; Fig. 1), whereas Clapperton et al. (1995) and McCulloch et al. (2000) found an extended glaciation along Strait of Magellanes (54°S) at least until around 12000 cal. years B.P. In this context it is still disputed, if Late Glacial glacier (re)advances of the southernmost Andes are related to the younger Dryas (around 12700 to 11500 cal. years B.P.; Denton et al. 1999, Lowell et al. 1995, Steig et al. 1998, Bulnier et al. 1998, Bard et al. 1997) or are related to N-S-shifting of the westerlies and related changes in precipitation (Lamy et al. 1999; McCulloch et al. 2000). Our study tries to constrain the ice retreat in the southernmost Andes from the proglacial lake Seno Skyring at 53°S until the small recent ice cap of the Gran Campo Nevado (see Fig. 2).

METHODOLOGY

Glacier derived sediments and moraines were investigated by mapping and remote sensing. Subaquatic moraine systems were detected by a Parametric Echo Sounder (details see www.innomar.com) in a profile, reaching from the eastern shore of the proglacial lake Skyring until fjord channels near to the pervious ice devide (Fig. 2). The ecosounding has a sediment penetration of up to 50 m and a high layer resolution (<5 cm; Fig. 3). Various cores were drilled into lake and fjord sediments as well as peat, to investigated the evolution of soils and the biosphere during deglaciation by using chemical and sedimentological methods. Stratigraphical control was obtained by ^{14}C ages and by a new tephrachronology (Kilian et al. 2003). A high resolution pollen record (1 anaylses/120 years) was obtained from a peat core taken near the previous ice divide, showing the vegetational history during the last 14442 cal. years B.P. (Fig. 1 and locality see Fig. 2 inset).

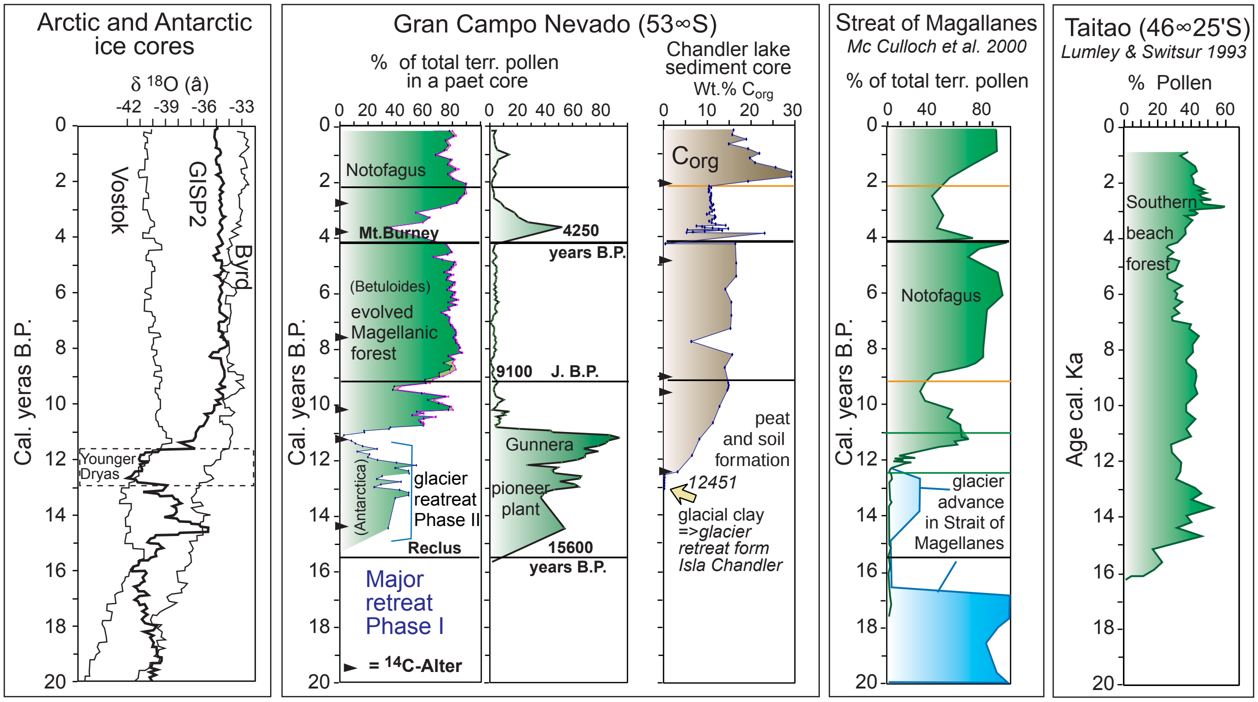

Fig. 1: $\delta^{18}O$ development of Antarctic and Greenland ice cores (Grootes et al. 1993, Johnson et al. 1972, Jouzel 1997) compared to a palynological record and organic carbon evolution in lake sediments from the Gran Campo area (localities see Fig. 2 inset). The forest evolution along the Strait of Magellanes (54°S; Clapperton et al. 1995; McCulloch et al. 2001) and Peninsula el Taitao (46°25'S; Lumley & Switsur 1993, Bennet et al. 2000) is shown for comparison.

RESULTS

Different moraine systems were detected along the transect shown in Fig. 2, each of them documenting stagnation or small re-advances of glaciers during the general ice retreat after the Late Glacial Maximum (LGM) which left the Phase I moraines of Rio Verde (Mercer 1970; Fig. 2).

PHASE II MORAINES

In the westernmost Seno Skyring a moraine system (Phase II moraines in Fig. 2) was detected, which marks a glacier retreat of around 80% of the maximum glacier length at the LGM. These moraines were formed previously to 15500 cal years B.P., since related ice rafted debris deposits, which were drilled in the eastern section of Seno Skyring, are overlain by the ~15000 cal. years B.P. tephra layer of Reclus volcano (Stern 1992; Kilian et al. 2003).

PHASE III MORAINES

Around 35 km southwest of the Phase II moraines, a further Phase III moraine system was observed in the Gajardo Channel (Figs. 2 and 3), for which we have no direct age constrains. 10 km to the southeast of Phase III moraines, the glacier retreated from Chandler Island (Fig. 2 inset). Late glacial to recent sediments were drilled in a small lake of this island. These sediments show a glacial clay at the basis and a sudden increase in C_{org} accumulation after 12451 cal years B.P. (Fig. 1), indicating a retreat of the glacier in the valley of the Gajardo Channel towards the west of the island (Fig. 2 inset) as well as the beginning of the evolution of soil and vegetation.

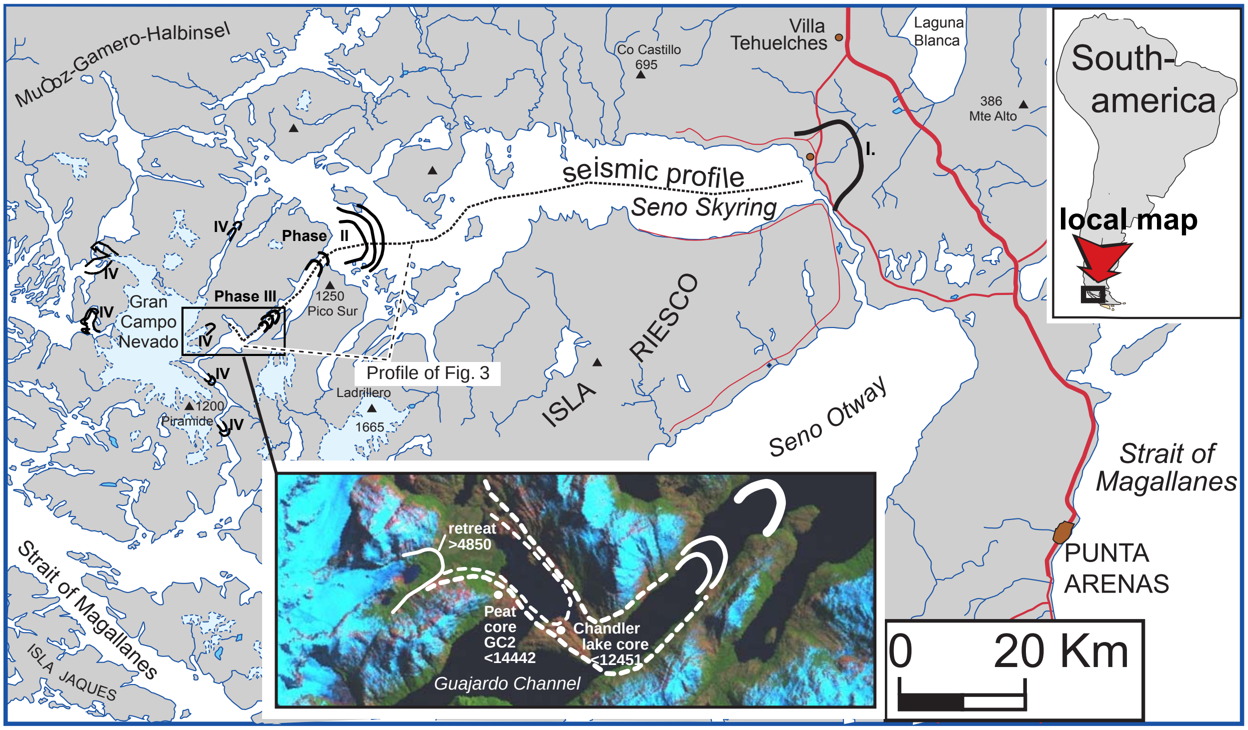

Fig. 2: Gran Campo Nevado Ice cap and Seno Skyring with glacier retreat phases II-IV. The maximum ice extension is marked by the Phase I Rio Verde moraine system (Mercer 1970) The inset shows a Landsat TM 5 image of the Gujardo Channel with lake and sediment core localities (details see text).

PALYNOLOGICAL RECORD

A palynological record covering the last 14500 years (Fig. 1) was obtained form a peat core sampled on the slopes of the ancient glacial valley, around 6 km to the west of Chandler Island (Fig. 2 inset). Between 14442 and 11012 cal. years B.P., this record is characterized by the species-poor association of the pioneric plant Gunnera magellanica together with Cyperacea and Notofagus, indicating a typical plant association on well drained moraines and glacial debris near to the glacier limit. Afterwards, until Mid Holocene, the palynological record shows a plant association which is typical for an evolved Magellanes rain forest (climax stage). This indicates constantly warm and humid conditions, similar as today. After the eruption of the Mt. Burney (4250 cal. years B.P.; Kilian et al. 2003) the palynological record (Fig 1) shows disturbances which are related to tephra deposition and sediment rework, but these effects need not necessarily to be related to climate fluctuations.

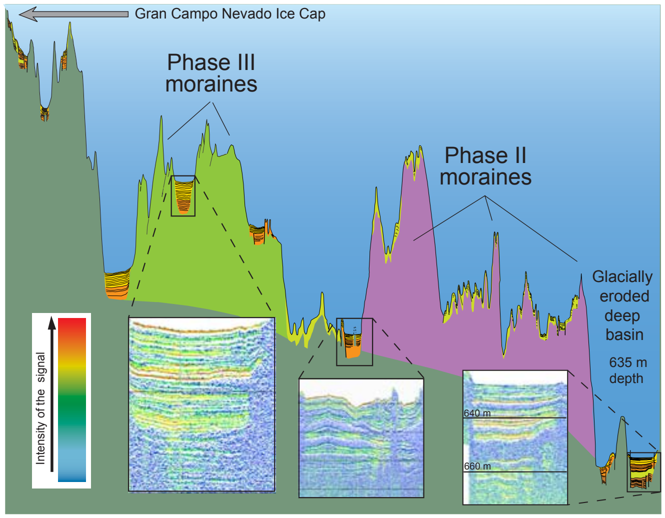

Fig. 3: Western section of the of the Skyring Profile, including the glacial valley of Guajardo Channel and showing baythmetrical and sediment echography with the moraine Phases II and II.

PHASE IV MORAINES

Between Chandler Island and the moraines of Phase IV of the Little Ice Age (LIA; Koch & Kilian 2001, Stickling at al. 2000) which were formed further 8 km to the west-northwest of Chandler, we did not find moraines or glacial debris. This suggests a very fast (?Late Pleistocene?) glacier retreat behind the LIA moraines. Soil and tree evolution and ^{14}C ages (4850 cal. years B.P.) from the section between moraine III and IV, indicate no glacier advance further than the moraines of the LIA at least during the last 5000 years.

Terrestrial moraines of the Little Ice Age were investigated by tree ring ages and forest successions (Koch & Kilian 2001). Further subaquatic LIA moraine systems of Phase IV were detected around the Gran Campo Nevado by ecosounding. These are shown in Fig. 2.

DISCUSSION

A palynological record and Chandler lake sediments constrain the formation of the Phase III moraine system between 14442 and 11012 cal years B.P. (Fig. 1). This indicates that the very fast glacier retreat after the LGM until at least 15500 cal. years BP was interrupted. The result is also consistent with glacier advances in the Strait of Magellanes until near to Punta Arenas between 14500 to around 12000 cal. years B.P. (McCulloch et al. 2000). This moraine formation and the interruption of the general fast glacier retreat can be due to a decline of the general warming trend, possibly related to the Younger Dryas or the Antarctic Cold Reversal (see ice Antarctic and Arctic ice core records in Fig.1) or can be also related to a southward migration of the westerlies (Lamy et al. 2001, McCulloch et al. 2000) with an increase of precipitation in the southernmost part of the Andes. The latter could explain, why this glacier re-advance phase of the southernmost Andes (53-54°S) was not observed further to the north at the Peninsula Taitao (46°S) (Fig. 1) and in the Lake District (39-41°S). However the late glacial moraines in the Gajardo Channel suggest smaller glacier extension than suggested for the same time in the Strait of Magallan by McCulloch et al. 2000 (Fig. 1).

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