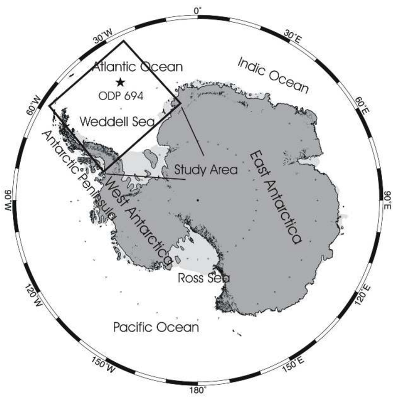
The sedimentary structure of the continental slope in the area of Larsen Shelf, Eastern margin of Antarctica



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INTRODUCTION:

The Antarctic Peninsula (AP) is the northern part of Antarctica and shows the most variable climate variations. Its western margin is bordered by the Pacific Ocean, while its eastern one faces the Weddell Sea and thus a colder climate. The long term climate conditions produced different shelf geometries and types of sediments along both margins. In addition the different tectonic histories (Pacific: convergent margin; Weddell Sea: rifted margin) of both regions had a pronounced influence on the style of the margin. While the Pacific margin of the Antarctic Peninsula is one of the geophysical best surveyed areas in Antarctica, the opposite is true for the eastern margin. Thick multiyear ice prevented any geophysical investigations in the last decades. A comparison of the sedimentary structure of both margins was so far not possible.

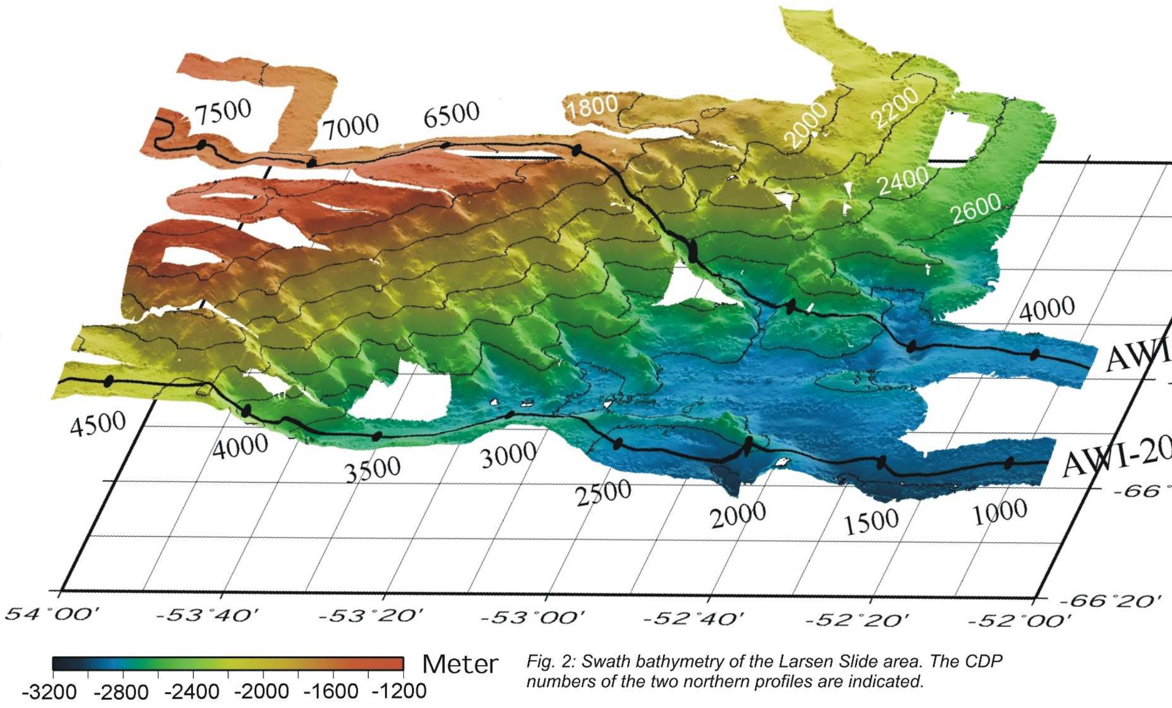

Fig. 2: Swath bathymetry of the Larsen Slide area. The CDP numbers of the two northern profiles are indicated.

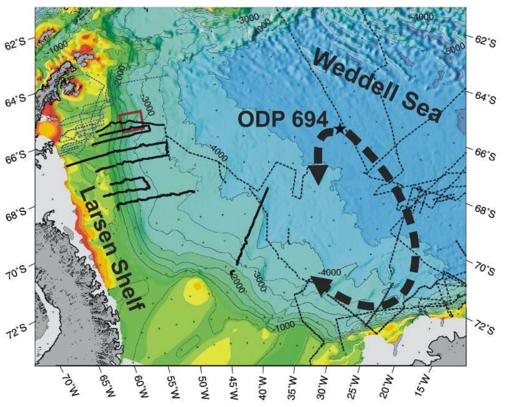

Fig. 1: Location of the MCS network in the western Weddell Sea and correlation paths (curved, dashed arrows) from ODP 694 to the slump area (bold rectangle). Bold black lines indicating the new MCS profiles (800m streamer, 24l-airgun array) acquired during austral summer 2001/2002. Blue lines show tracklines NBP 93-1 and PD 91 of U.S. Antarctic Programm (Sloan & Lawver, 1993; Sloan et al., 1995).

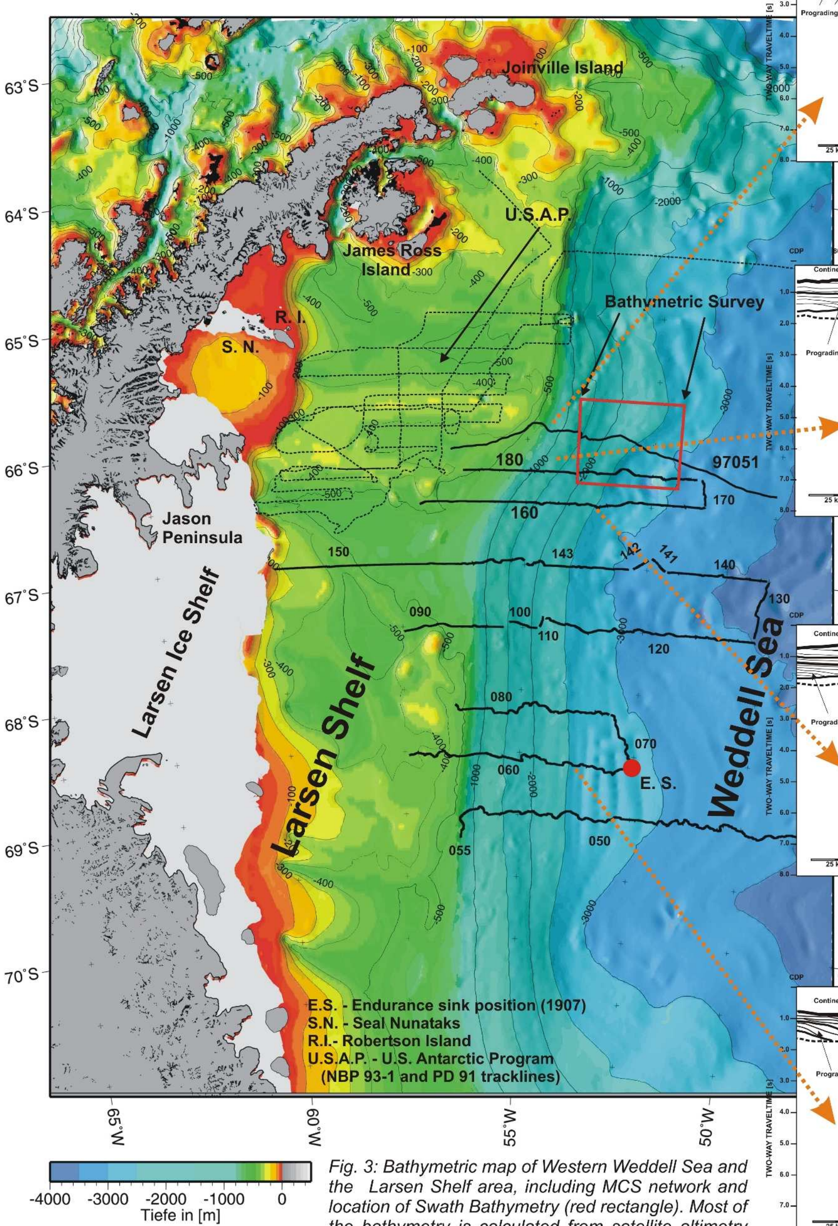

Fig. 3: Bathymetric map of Western Weddell Sea and the Larsen Shelf area, including MCS network and location of Swath Bathymetry (red rectangle). Most of the bathymetry is calculated from satellite altimetry data.

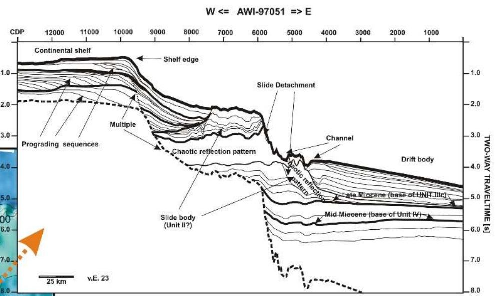

Fig. 3a: Line drawing of profile 97051.

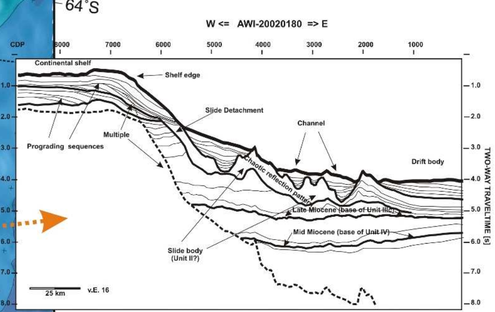

Fig. 3b: Line drawing of profile 20020180.

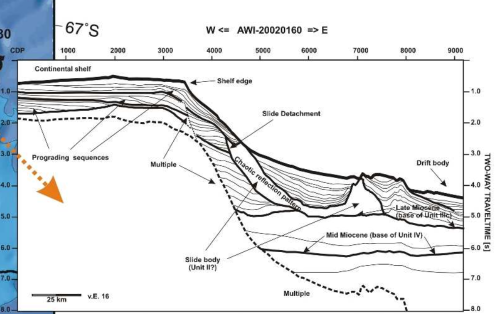

Fig. 3c: Line drawing of profile 20020160.

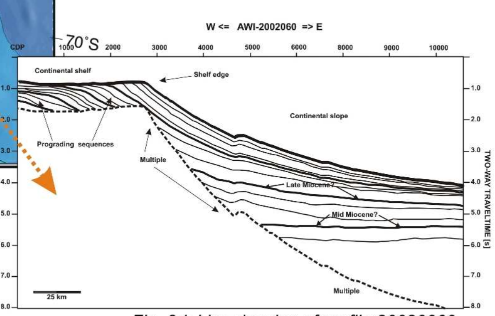

Fig. 3d: Line drawing of profile 20020060.

RESULTS:

Up to 50km west of the shelf break the acquired seismic data clearly show the presence of glacio-marin prograding sedimentation pattern (Fig. 3a, 3b, 3c, 3d). Dips of the continental slope range from 1° to 3°, slightly increasing to the north. Sedimentation patterns of the shelf at 68°S show undisturbed prograding sequences (Fig. 3d) while the northern profiles show slumps, chaotic reflections and channel/levee structures at the foot of the slope. Between the two seismic lines 97051 and 20020180 a large slump was found (between 65°30'S and 66°30'S) in the lower part of the continental slope at a water depth of 1700 m. From the detailed bathymetric survey (Fig. 2) we estimate that the sediments affected by the slide are in a 70 km N-S and 100 km E-W direction.

At 2800 m the foot of the through regular spaced canyons disrupted slope (4° dip) is reached and levels out into the deep abyssal plain of the Weddell Sea. Seaward, in more than 60 km distance from the erosional surface (original slide location) the seafloor features several hills, which represent in part the slide material (Fig. 1b, CDP 4000-4500; Fig. 1c around CDP 7000) and also current-controlled deposits (Fig. 3b, CDP 1500-2000; Fig. 3c CDP 7500-9000). East of the hills a young levee system identified through driftbodies has been initiated by interactions with the slide-created topography.

Causes and Age of the slide

The existing MCS network in the Weddell Sea as well as ODP drill site 694 stratigraphy were used to provide an approximate age for the slide event (Fig. 1). Two strong reflectors corresponding to the base of Unit IV (middle middle Miocene approx. 14-15 Ma) and base of Unit IIIc (middle late Miocene approx. 8 Ma) (Barker & Kennet, 1988) where used for the correlation.

The sediment pattern of Unit IV support interpretations that strong glacial sedimentation along the eastern AP margin did not take place before the late Miocene (Barker & Kennet, 1988).

Barker & Kennet (1988) report also that Unit II (lowermost Pliocene 4,8 Ma) consists of a 90m thick sandy turbidite sequence, which was deposited extremely rapidly (~180m/Ma) within an interval of only 0.5 Ma or less during the Gilbert Chron (C3R4) before 4.8 Ma.

The base of Unit IIIc correlates well with the approximate base of the slide (Fig. 3a,3b,3c). According to the ODP stratigraphy, we speculate that some Early Pliocene sediments were deposited on top of Unit IIIc before the massive sandy turbidite sequence overlayed this strata.

Thus, we suggest that the 90 m-thick deposits of Unit II are the distal traces of a giant slide occurred around 4.8 Ma.

Seafloor failures are often triggered by events, which affect the stability of the slope. Important triggers can be oversteepening by non-uniform deposition, erosional undercutting, excess of pore pressure, discharging gas or hydrate decompositions, sea level change and earthquakes (Pratson, 2000). Along the eastern margin of the AP Plio/Pleistocene back-arc volcanism occurred first at 7 Ma, at James Ross Island. Almost 150 km south of the island at around 65°S, 60°W, the volcanic sequence of the Seal Nunataks erupted between 6.5 to 1.3 Ma (Gonzales-Ferran, 1983a). Gonzales-Ferran (1983a,b) ascribe the Seal Nunataks to typical rift tectonic processes with its peak during the Pleistocene, based on K/Ar ages.

The Nunataks lie west of the slide area (distance of 300 km) and were active at the same time as the proposed mass wastage event. Thus, we suggest that earthquakes, accompanying the eruptions of the Seal Nunataks, in combination with the massive prograding West Antarctic ice shield, triggered the slide event in Pio/Pleistocene times around 4.8 Ma.

References:

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