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Seismic stratigraphy of the East Antarctic margin: a record of Cenozoic environmental changes

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We have analyzed more than 120000 km of MCS sections collected on the East Antarctic margin (EAM) from 7E to 142E to correlate seismic stratigraphy with Antarctic glacial history predicted from drilling data and deep-sea proxy records, and to estimate what sort of information about ice sheet behavior and paleoceanographic conditions is contained in seismic records. Most of analyzed MCS lines are located on the continental rise and only the Prydz Bay (PB) shelf was studied in details.

Five mayor horizons numbered up-section from “1” to “5” are identified in sedimentary cover of deep water EAM (continental rise). Horizon “1” and “2” are correlated with asynchronous Gondwana breakup and early post-breakup events, respectively; horizons “3”, “4” and “5” are proposed to be isochronous surfaces related to Late Cenozoic paleoenvironmental transitions. The distinguishing feature of EAM sedimentary cover is the clear upward change in reflection pattern across horizons “3” and “4” that separates a lower sedimentary unit with mostly parallel reflectors from an upper one consisting of variety of acoustic facies typical of active down-slope and along slope processes. This change is associated with the arrival of the ice sheet to the Antarctic margin and significant increase in sedimentary input to deep water regions. Major results of our study are following:

1) Widespread development of channel-levee systems and other facies related to mass-wasting on the EAM is observed above horizon “4” and this interface is proposed to mark continental-scale Antarctic glaciation in the Early Oligocene. However, earliest signs of active down-slope processes are revealed on the Wilkes Land margin (WLM) above horizon “3” and we infer that this margin was glaciated first, probably in the Late Eocene. Under the temperate climate condition debris was delivered to the slope and rise by glaciers (which flowed from central Antarctica via Aurora Subglacial Basin) and abundant melt-water. The rate of sedimentation (debris flux to the deep-water area) on the western WLM during the Late Eocene was anomalous. Some other parts of EAM show evidence of fluvial deposition and contourite drifts development at this time. During the Oligocene the rate of sedimentation on EAM was changeable ranging from 30 to 100 m/m.y. implying that ice sheet dynamics were not uniform over the space.

2) Horizon “5” is well defined on the margin between 35E and 100E where it denotes wider development of channel/levee systems and contourite drifts, and less distinctive on the other part of the EAM. The age of horizon “5” is estimated to be about 24 Ma. The rate of Oligocene glacial marine sedimentation on the continental rise is calculated to be 40-60 m/m.y. but it is twice as much off western PB and on western WLM.

3) The rate of sedimentation during the Early-Middle Miocene was 80-100 m/m.y. off PB and on the western WLM and a little less on the other part of EAM. At about Middle Miocene, sedimentation rates on the continental rise decreased dramatically. Shelf progradation was active but depocenters began to shift landward from the continental rise. During post-Early Pliocene time, rates of sedimentations on the rise are minimal and focused mostly on the continental slopes; shelves show local aggradation (shelf banks), erosion, trough-mouth fans (locally) and progradation.

4) Thickness of syn-glacial sediments on EAM averages 1.2-1.5 km but off PB and on western WLM it amounts to 2.5 km. These areas correlate with places where present-day ice discharge is highest. The correlation points to high sediment (and ice) flux in the same areas from the Early Oligocene to the Middle Miocene. Structure of buried and modern submarine channels in a post-Early Oligocene strata and their evolution through time are different along the EAM and depend mostly on activity of down-slope currents and turbidite flows.