FUTURE ANTARCTIC MARGIN PALEOCLIMATE SCIENTIFIC DRILLING

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ABSTRACT

Scientific drilling in and around Antarctica and the Southern Ocean is undertaken within the framework of the Antarctic Treaty and other international agreements through a wide range of research activities coordinated by the Scientific Committee on Antarctic Research (SCAR). and supported by the individual national Antarctic Programs. The SCAR-Antarctic Climate Evolution (ACE) initiative and its sponsored projects and programs identify scientific questions and develop hypotheses and integrated strategies that can be implemented through drilling, numerical modeling, and other activities in the circum-Antarctic region. SCAR-ACE projects such as the Antarctic Geological Drilling Program (ANDRILL), the Circum-Antarctic Seismic Stratigraphy and Paleobathymetry Project (CASP), the Antarctic Landscape Evolution Project (ANTscape), and the Antarctic Seismic Digital Library System (SDLS), amlng others, serve to inform and guide ongoing discussions about community scientific priorities and and long-term planning. These promise to achieve global science outcomes that combine process studies, drilling of critical climate archives and numerical modeling. New results from the ANDRILL Program (Naish et al, 2009; Pollard and DeConto, 2009) provide an important example of how paleoclimate records integrated with climate and ice sheet modeling can help constrain future change. We present the core of a multinational, multiplatform scientific drilling strategy to recover key physical evidence constraining past and future Antarctic Ice Sheet behavior, which is aimed at addressing key knowledge gaps about the role of Antarctic ice sheets in climate change as identified by the Intergovernmental Panel on Climate Change (AR4, IPCC, 2007).

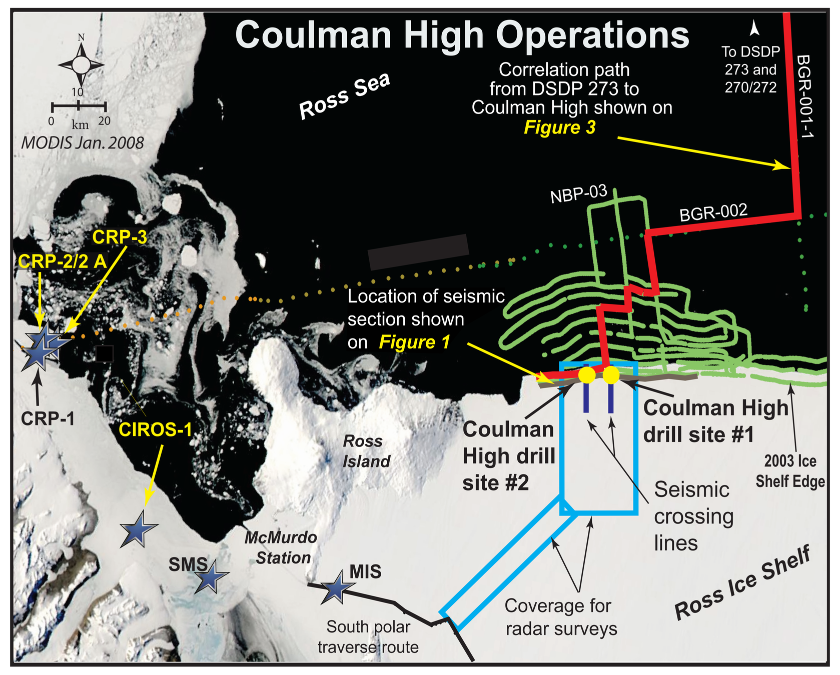


Figure 1.

The ANDRILL Program completed two 1 km+ holes in McMurdo Sound (MIS, SMS) during the IPY, and will now move east of Ross Island to the ice shelf over Coulman High. Here it will utilize new drilling capabilities to operate from a fast moving ice shelf platform (~740 m/year northward) and complete two deep holes **(CH-1, CH-2; Fig 1).** The target for the proposed Coulman High Project is a Cretaceous (?) - Paleogene to lower Miocene section based on correlation to DSDP sites.

Drilling at Coulman High will investigate: (1) the evolution of the West Antarctic Ice Sheet in a period of high greenhouse gas levels; (2) the Antarctic environment in warm greenhouse periods; (3) controls on Oligocene and Miocene climate and cryosphere; and (4) tectonic processes within the West Antarctic Rift System.

Drilling will require melting through the ice shelf with a hot water drill (Fig. 2). Operational challenges will result from the movement of the ice shelf northward over the sea floor at ~2 m/day. Deflection of the riser cannot be more than 8% of the water layer thickness of 630 m (below ice base) and constrains drilling depth to a maximum of ~500 m. To reach targets at > 1000 m below sea floor, two options are being considered; to pull out and move the rig back over the site and reenter the hole, or to pull the string at the end of the drilling and wash down to the prior depth at a new offset site and drill and core below that depth (Fig. 3).

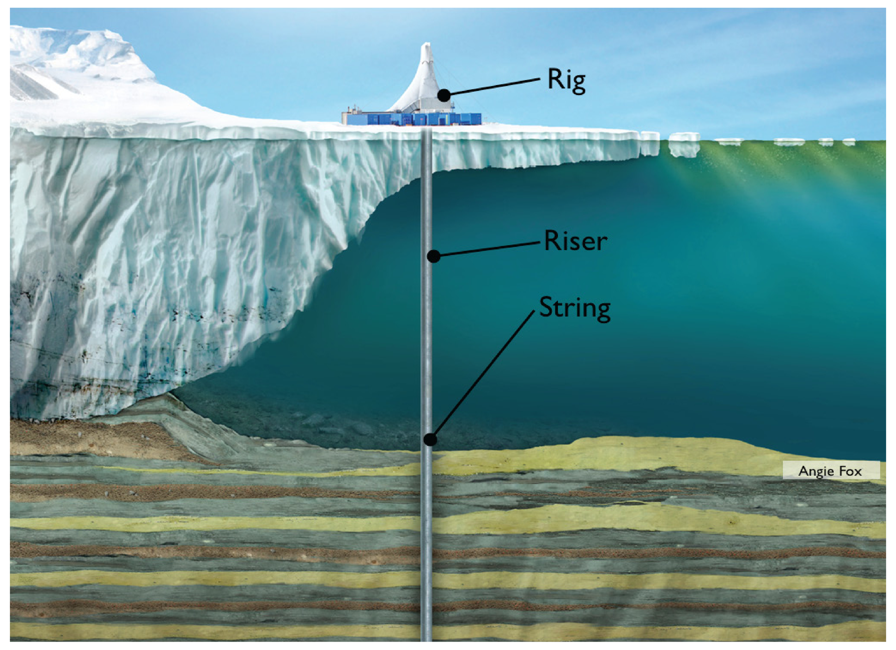


Figure 2.

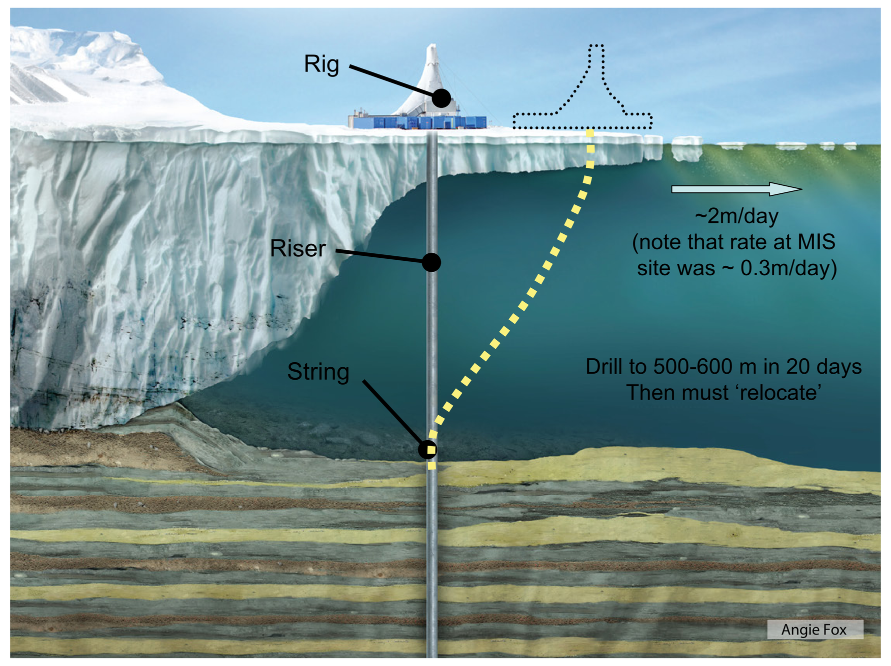


Figure 3.

The SCAR-ACE community is currently leading an international initiative aimed at addressing the critical lack of high-quality climate records from the Antarctic continental margin. A workshop was held in September 2009 to develop a 20 year research strategy, beginning by identify areas where drilling is needed and where suitable geophysical survey data is available. The goal of this effort is to produce a blueprint for future international collaboration, driven by scientific questions, that makes effective use of the available range of drilling platforms and opportunities. The research strategy is designed to resolve the sectoral response of the West and East Antarctic Ice Sheets and margins to climate perturbations over the Cenozoic.

Antarctic Scientific Drilling - Workshop Summary

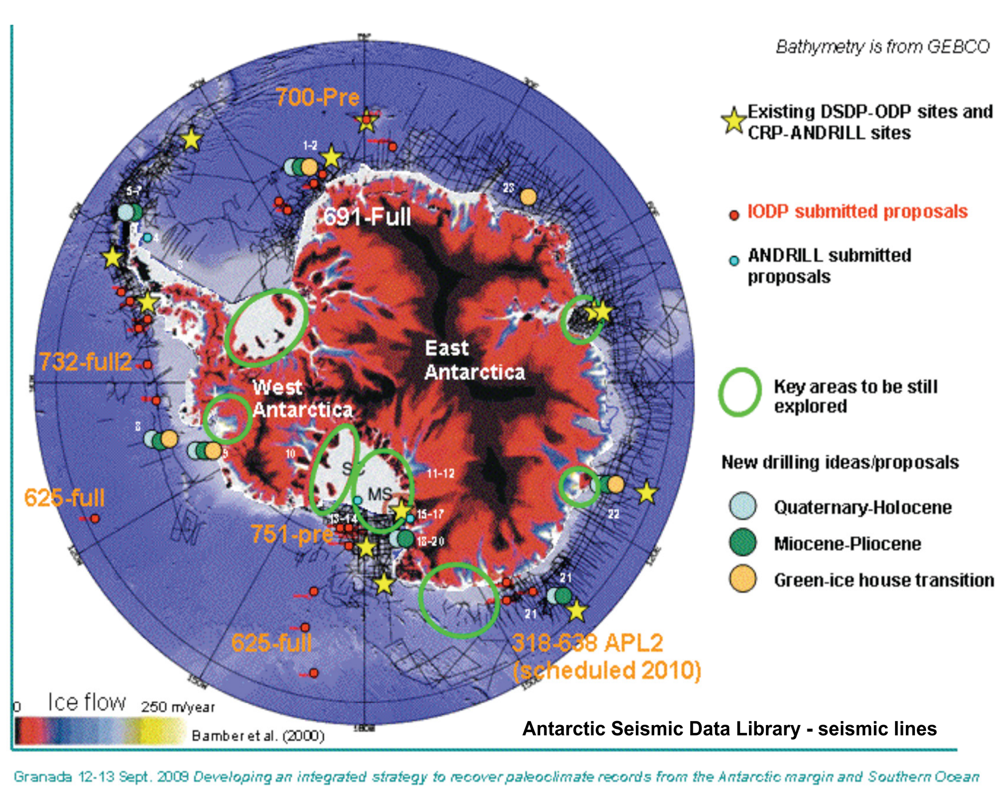


Figure 4.

Figure 5.

Proxy data for the past 60 million years :

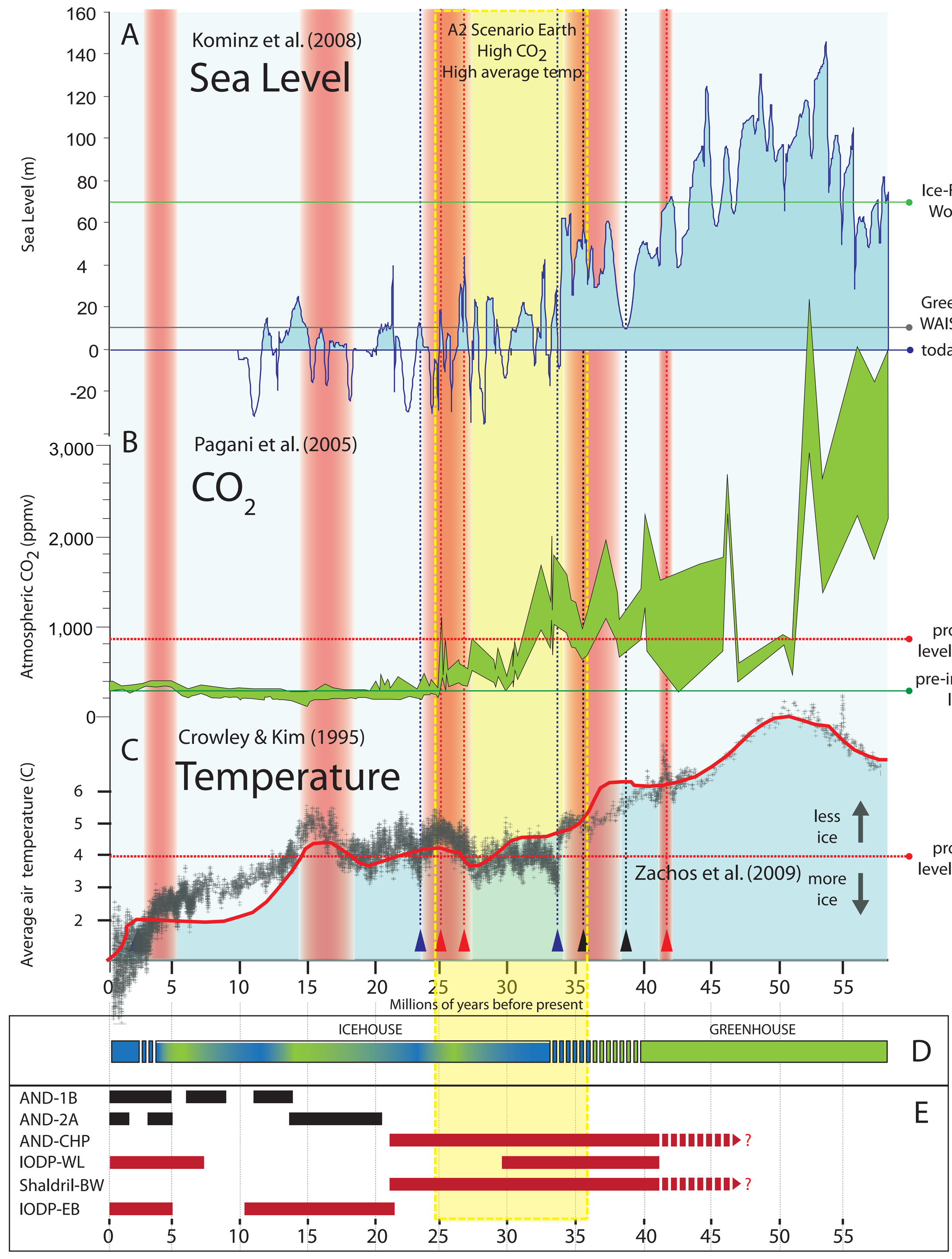
A. Eustatic sea level. Horizontal line 1 is the amount of global sea-level rise if both the Greenland Ice Sheet and West Antarctic Ice Sheet were melted and line 2 is amount of global sea-level rise if all present day ice on Earth was melted;

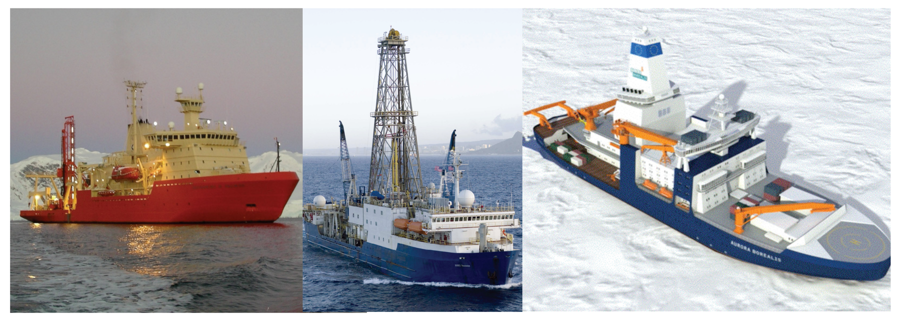
B. Atmospheric carbon dioxide levels. The horizontal dashed red line is CO_2 level projected for 2100 AD for the IPCC A2 scenario;

C. Global atmospheric temperature curve (bold red) based on deep-sea oxygen isotope records. A compilation of isotope data is in black. Red bands are periods of global warmth.

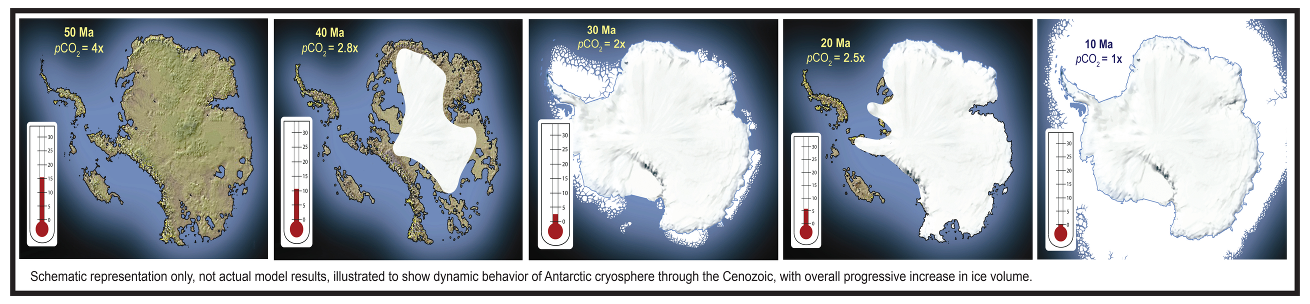
D: Gross scale ice sheet history from deep-sea oxygen isotope records and geologic data from the circum-Antarctic.

E: bar chart indicating the geologic time periods previously recovered by ANDRILL (black) and targeted by future drilling projects. The pale yellow box (dashed yellow border) is the period when CO_2 levels and atmospheric temperatures were last at the levels projected for 2100 AD by the IPCC A2 scenario.





Scientific Vessels used for Antarctic margin drilling.



Ice models by D. Pollard, with E-O climate and isostatic adjustment

Figure 6

Maps of Antarctic topography with restorations for removal of the load of modern ice only (a, BEDMAP adj.), and additionally for erosion, sedimentation, thermal contraction, and horizontal plate motion in geologically active regions (b, from *Wilson & Luyendyk (2009)*; WL09). Models correcting only for ice load have been used in all simulations of ice growth (c) to date, but significant changes result from additionally correcting for other geologic processes (d). Star in a and b shows location of CH site. Ice models show more ice growth on West and East Antarctica for the WL09 model (d) than for BEDMAP (c).