Idea409

The Age of Antarctic Permafrost

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Objective.

To determine the age of Antarctic Permafrost

Brief rationale

Antarctic Permafrost age is supposed to be much older than the Arctic one. However it has not been studied extensively. On the other hand, Antarctic frozen soils are extremely poorly studied (in comparison with the ice sheet), although the permafrost is more stable and older, thereby making itself potentially more informative than Antarctic ice cover. A number of studies indicate that the Antarctic Cryosphere began to develop soon after the final break-up of Gondvana and the isolation of the Antarctic continent with glaciation has been initiated about Eocene-Oligocene boundary. Interpretations of proxy records from deep sea studies suggest significant ice sheets existed on the Antarctic continent throughout the Oligocene, c. 34-26 Ma, decaying to a relatively warm (but potentially still glaciated) climatic optimum in the middle Miocene, c.5 Ma. Analysis of the geomorphic evolution of the Dry Valleys region testifies that the landscape evolved to near its present state prior to the middle Miocene (c. 14 Ma) and the environment has been maintained in a cryospheric stasis since the middle Miocene. Marine diatoms and *Nothofagus* leaves and pollen in glacigene Sirius Group strata, however, indicate a significant warming of the Antarctic climate in Pliocene times. But some doubts exist that the warm interval in the Pliocene could be sufficient for affecting the Cryosphere substantially. The discussion on Neogene stability has focused mainly on the state of the ice sheet that is the most variable part of Cryosphere. The permafrost is the more stable Cryosphere end-member and the conditions needed for its degradation (the geostatic pressure, ocean-continent interactions, atmospheric water circulation), even if they existed in middle Miocene or early Pliocene climatic optima, were not enough to permafrost thaw. Permafrost degradation is only possible when mean annual ground temperatures rise above freezing point. The temperatures measured in this study vary between -18,5 and -27^{o}C and so a significant warming (20 ^{o}C or more) is required to degrade the permafrost once formed. There is no evidence of variations in temperatures such significant that the Antarctic climate and geological history were favorable for the formation and persistence of pre-Pliocene permafrost. Antarctic permafrost may, therefore, be more than 30Ma and date from Antarctic ice sheets predicted in early Oligocene times. The ancient ice horizons discovered below the ash layer (^{40}Ar/^{39}Ar dates > 8 Ma) in Dry Valleys are suggested to be oldest known. The age has been recently confirmed by surface exposure ages. These data indicate that permafrost here is at least of the same age is still critical. The top of the ice horizon occurs at been 4.0 and 7.0 m depth and ground penetrating radar studies indicate that the ice may persist to more than 200 m depth. In Beacon Valley, a sandy-pebble layer sandwiched in ice was encountered at 14 to 15 m depth in borehole, which penetrated to beneath the reported Miocene ash layer. Cosmogenic ^{10}Be measurements of the ice and embedded quartz grains from cores indicate a minimum age of 500 000 years and whiles this does not confirm the stratigraphic age of 8.1 Ma, it does not preclude it. From an age perspective, the Glacial Sirius Group sediments on Mt. Feather may be older. They were previously estimated to be at least 2 Ma in age and possibly as old as 15 Ma. Ages for permafrost are > 5 Ma on Mt. Feather indicated by near "in-situ" Late Miocene non-marine diatom forms. In the Arctic, the oldest continuously frozen layers with the cryogenesis traces are middle Pliocene shingles; the most ancient in the North Hemisphere date to 3 Ma. Frozen ground recovered in cores from Mt. Feather and probably in

Beacon Valley is estimated to be more than 5 and 8 Ma old, but may date from the formation of frozen ground more than 30Ma ago. The next step is to found – during the Polar Year 2007/08 – the oldest Antarctic permafrost, whose relicts should search at the high hypsometric levels (for example, along the Polar Plato).If this age is correct, this suggests that permafrost has existed under Antarctic climatic and geological conditions for the last dozen of millions of years, greater than the duration of Arctic permafrost by a factor of ten and that during most time of late Cenozoic our planet exists with only one cold Pole in South Hemisphere.

<u>Expected results</u>

Revelation of correlations between geothermal history of permafrost and climatic global changes in the late Cenozoic era

<u>Main types of research activities</u>

Field observations, core sampling, radioisotope and microbiological analyses, modelling.

2006 -2008, Antarctic.

Antarctic Permafrost has not been studies as extensively as the Arctic though that permafrost age here may be much older. From the hand, Antarctic Permafrost soils, have not received as much cryological study as has been devoted to the ice sheets, although the permafrost is more stable and older, thereby making it potentially more informative than the ice sheet.

A number of studies indicate that the Antarctic Cryosphere began to develop soon after the final break-up of Gondvana and the isolation of the Antarctic continent with glaciation believed to have been initiated in the vicinity of Eocene- Oligocene boundary. More controversial, however, is the longevity and permanence of Antarctica's ice sheets following initiation. Interpretations of proxy records from deep sea studies suggest significant ice-sheets were presented on the Antarctic continent throughout the Oligocene, c. 34-26 Ma, decaying to a relatively warm (but potentially still glaciated) climatic optimum in the middle Miocene, c.5 Ma. Direct evident from the Antarctic continent indicates large fluctuations in ice volume and periodic glacial advance and retreat in the early Miocene. When such dynamism gave way to more stable and permanent ice sheets is the subject of on-going debate.

Analysis of the geomorphic evolution of the Dry Valleys region indicates that the landscape evolved to near its present state prior to the middle Miocene (c. 14 Ma) and the environment has been maintained in a cryospheric stasis since the middle Miocene. Marine diatoms and *Nothofagus* leaves and pollen in glacigene Sirius Group strata, however, indicate a significant amelioration of the Antarctic climate draw down of the East Antarctic Ice Sheet in Pliocene times. But, those who argue for stability of the ice sheets throughout the late Neogene doubt that the warm interval in the Pliocene would not have been sufficient to affect the Cryosphere to a substantial degree.

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-27^{o}C and so a significant warming, 20 ^{o}C or more, is required to degrade the permafrost once formed. There is no evidence to date of such significant variations in temperatures, indicating that the Antarctic climate and geological history were favorable for the formation, and persistence, of pre-Pliocene permafrost. Antarctic permafrost may, therefore, be more than 30Ma and date from Antarctic ice sheets predicted in early Oligocene times.

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