Multiplying Grand Unsolved Problems in Palaeoglaciology

The existence of the West Antarctic Ice Sheet was palaeoglaciology's grand unsolved problem 20 years ago.[1] The West Antarctic Ice Sheet, unlike the East Antarctic Ice Sheet, is mostly grounded 0.5 to 1 km below sea level. A major fraction of its bed would still remain below sea level if the ice sheet were removed and the land allowed to rise isostatically. It is after isostatic relaxation that the original glaciation of West Antarctica must be considered. Besides questions of how the West Antarctic Ice Sheet remains in existence, and whether the fast ice streams draining the ice sheet onto large floating ice shelves will cause its disintegration in the future, there is one overarching question: 'How then did this ice sheet form?'[2] In other words, how does a thick ice sheet develop over an area of mostly ocean, dotted with mountain ranges? This question still is glaciology's grand unsolved problem.

Recently, we have been informed that there is a second grand unsolved problem in palaeoglaciology, this time in the Northern Hemisphere.[3] This unsolved problem is whether a large marine ice sheet formed, grew, and collapsed in the Arctic Ocean during the Pleistocene ice age, analogous to the case with the West Antarctic Ice Sheet. The reason an Arctic ice sheet is entertained is mainly because of several semi-grand problems within palaeoglaciology.

The first problem is the realisation that the terrestrial ice sheets during the Pleistocene over northern North America and Eurasia must have been nucleated over mountains or highlands, but would have remained stationary (a drastic climatic change would be required even for these small ice caps).[4] Secondly, in a number of high latitude regions, much of this ice would be depleted by calving into the ocean. Thus, only local ice caps would remain in these areas and not spread. Over the past 30 years, the numerous computer modelling efforts to simulate glaciation of the Northern Hemisphere have rarely incorporated ice calving, which actually is the dominant ablation mechanism[5] (few modelling efforts succeed anyway, and those that do succeed often do so by unrealistic parameter manipulations and special initial conditions).[6]

A third reason for postulating an Arctic Ocean ice sheet is because there was not enough ice in the past ice sheets to account for the high oxygen isotope ratios ($^{18}O/^{16}O$) in the oceans and the drop in sea level believed during the ice age.[7] A high oxygen isotope ratio in the ocean and a sea level drop of 160 metres is postulated by the thick ice sheet model. However, many scientists, based on empirical evidence, now favour a thinner ice sheet model. Actually, the oxygen isotope values in the ocean, the amount of sea level drop, and the thickness of former ice sheets are all subjective, often based on modern analogues and ice age theory.[8] So, a thick ice sheet postulated over the Arctic Ocean, starting on the Arctic Ocean continental shelves and building poleward, is offered as the solution to several Northern Hemisphere glaciation problems.

The grand palaeoglaciological problem in the Northern Hemisphere, then, is to develop this Arctic Ocean ice sheet. The authors admit that the former existence of this Arctic Ocean ice sheet is hypothetical. The best evidence comes from the Barents Sea area, north of Norway, where there could have been a local ice sheet at glacial maximum.[9] The remaining area of the Arctic Ocean and northern Siberia offers little evidence for an Arctic Ocean ice sheet. One of the main problems is that the Quaternary geology of northern Russia and Siberia is poorly known, mainly because of poor accessibility and glacial features that are destroyed or covered up by periglacial processes. In making a case for northern Siberian glaciation, the authors reject much previous glaciological interpretation of the area and many of the dates. They directly indite the methodology and validity of both.

The uniformitarian ice age model has many serious deficiencies. In fact, an ice age is really a non-uniformitarian phenomenon:

> *'If they hadn't actually happened, the ice ages would sound like science fiction.'*[10]

A catastrophic post-Flood ice age model can not only explain glaciation in the Northern Hemisphere, but also the glaciation of West Antarctica[11] — both grand unsolved problems in 'uniformitarian' palaeoglaciology.

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