

## Evaporite-basin size as a proxy for Palaeozoic glaciation?

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The Late Palaeozoic was characterized by long-lasting southern-hemisphere glaciation, as evidenced by a rich record of glaciogenic sediments on Gondwanan continents. In the northern hemisphere polar glaciation is reflected in thick coal-bearing sequences that dominate Euramerican basins; these were deposited in response to glacio-eustatic sea-level fluctuations. Based on various types of data the Late Palaeozoic Ice Age has been interpreted to span the entire Carboniferous and Permian periods.

Marine halite bodies were deposited in intracratonic basins throughout the Palaeozoic era, during both glacial and non-glacial episodes. The bodies are particularly common in large basins, but they occur in smaller basins as well. An inventory of Palaeozoic halite-bearing basins shows that halite accumulated in both small and large basins ( $10^4$ - $10^7$  km<sup>2</sup>) during the Devonian greenhouse. Following the onset of glaciation at the start of the Carboniferous halite accumulation only took place in relatively small basins ( $\sim 10^5$  km<sup>2</sup>), and during the Late Pennsylvanian glacial maximum in minibasins ( $10^4$  km<sup>2</sup>) only. Only after the initiation of glacial retreat during the Early Permian halite precipitated again in giant basins. Initially some of these are “continental” evaporites; during the Late Permian fully marine evaporite successions were laid down in a number of large basins.

The close relation between evaporite-basin size and the long-term glacial history suggests that glacio-eustasy controls the probability that intracontinental basins become isolated to the point of basin-wide halite precipitation. The reason that larger basins experience halite precipitation only during periods of low-amplitude or no glacio-eustasy may be that more time is available for the closure of the narrow/shallow ocean corridor when sea-level change is limited.

In contrast to the Late Palaeozoic the Early Palaeozoic glacial history is poorly understood. It is well established that the Palaeozoic started with prolonged Cambro-Ordovician greenhouse conditions, followed by glacial conditions during the second half of the Ordovician. However, some envisage the Ordovician glaciation as a short punctuated event, whereas others see evidence of ongoing glaciation well into the Late Silurian. Our analysis shows that the distribution of evaporite basins in the Early Palaeozoic is quite comparable to that of the Late Palaeozoic, with large evaporite basins during the Cambrian and Early Ordovician (greenhouse), followed by medium-sized basins from  $\sim 490$  My onwards (coincident with first shoreline-ice deposits) and small basins ( $\sim 5 \cdot 10^5$ ) from  $\sim 450$  My onwards (coeval with the well established Hirnantian glaciation). Throughout the Silurian evaporite basin remained small, or are absent.

The Early Palaeozoic evaporite-basin pattern closely resembles that of the Late Palaeozoic, and is of comparable duration. Therefore we conclude that the Early Palaeozoic glacial history was more prolonged and continuous than commonly assumed.