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The gradual closing of the Indonesian Seaway and the onset of northern hemisphere ice ages

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American Mountaineering Center

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Abstract

The gradual closing of the Indonesian Seaway and the onset of northern hemisphere ice ages

By Peter Molnar,

A logical argument can be made that the closing of the Indonesian Seaway transformed the shallow, tropical Pacific Ocean from a state resembling that during large El Niño events to its modern weakly La Niña state, and with that change, atmospheric heat transport to Canada decreased sufficiently to permit the growth of large continental ice sheets. The steady northward movement of New Guinea and the concurrent emergence of islands in the "Maritime Continent" (largely Indonesia) has blocked relatively warm Pacific water south of the equator and enabled cooler water from the northern Pacific to escape into the Indian Ocean (the "Indonesian Throughflow"). Blocking of that warm water may have strengthened easterly winds and amplified an east-west temperature gradient. Paleoceanographic evidence, indeed, shows a gradual cooling of the water in the eastern Pacific to its present-day "cold tongue" that flows at the equator half way across the eastern equatorial Pacific. Thus, the sea surface temperature of the eastern Pacific has gradually changed from the warm state that is reached only rarely today during major El Niño to its more common present-day cold state. Moreover, during present-day El Niño events, distant regional climates respond, via “teleconnections,” in varying ways in response to the changes in sea-surface temperatures in the eastern Pacific.

Similarly, paleoclimates from most of the earth differ from normal present-day climates. These differences, those between paleo- and typical modern climates, resemble those associated with modern teleconnections, which corroborates the idea that before ~3 Ma, the tropical Pacific Ocean was in a state similar to that during El Niño events. For example, during El Niño events, not only do winters in Canada become atypically warm, but also summers last longer than normal. An assessment of the dependence of positive-degree days in Canada associated with El Niño events, together with empirical estimates of melting rates of snow or ice as a function of positive-degree days, suggests that an eastern Pacific 3- 4 degrees C warmer than today, as it was at 3-4 Ma, sufficed to melt winter snowfall and prevent ice sheets from growing. The gradual cooling of the eastern Pacific and reduced atmospheric heat transport finally enabled ice
sheets to grow.