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# Stronger tropical cyclones in the warmer geological past – a possible explanation for abnormally low $\delta^{18}$O rain

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In three points in time in the geological column of Israel we find indications of "too low" $\delta^{18}$O rainwater. These are (a) the matrix of chert breccias in the Campanian Mishash Fm. Throughout the Negev ($\delta^{18}O_{Si}$ $\approx$ 21-27â) , (b) Silicified fossils in the Eocene Matred Fm. ($\delta^{18}O_{Si}$ $\approx$ 22-26â), and (c) lacustrine carbonates of the Mashaq Member in the Miocene Hazeva Fm. ($\delta^{18}O_{CC}$ $\approx$ 19.5-23.5â) In all three cases the deduced meteoric water with which these rocks equilibrated must have had $\delta^{18}$O values as low as -8 to -12‰ (SMOW). Present-day rain in Israel has values in the range of -4 to -7‰. Fresh-water carbonates of post-Hazeva age have isotopic compositions similar to present day carbonates of the area. The geographical location of Israel was throughout the Mesozoic and Cenozoic at lower latitudes than its present location. Neither was Israel located deep inland a continent or surrounded by high altitudes. Hence we propose that the strong $^{18}$O depletion is a reflection of different atmospheric circulations in the geological past. The reconstructed paleo-climate and hydrometeoric $\delta^{18}$O are consistent with dominance of summer monsoon rainstorms. The composition of the lightest present day equivalent monsoon rainfall in Southeast Asia, especially when taking into account the higher paleo-SSTs, is still heavier than the deduced paleo hydrometeoric waters. The only means that we are aware of to make the water lighter is increasing the rainfall contribution from tropical cyclone beyond the level that is presently occurring. If so, it means that the past warmer sea surface

temperatures induced greater tropical cyclonic activity than in the present climate.