SUPPLEMENTARY INFORMATION

Methods

The $\delta^{13}C$ and $\delta^{18}O$ values were measured relative to the V-PDB standard using a VG PRISM II stable isotope mass spectrometer equipped with a common acid bath acidification system. A calcite standard (ULTISS) was used to monitor precision (mean = 1.73‰, standard deviation = 0.24‰). For [CAS] measurements, approximately 1.5 mg of micro-drilled powdered sample was acidified with 1 ml of 10% nitric acid and analyzed with a JY Ultima-C ICP-AES with Polychronometer. A repeat measurement of a standard solution gave an error of 0.6%.

Table DR1. Measured Values

Sample	$\delta^{13}C$	$\delta^{18}O$	S (ppm)
BBR-B8 (top)	-7.597	-6.329	1059.71
BBR-B7	-7.131	-6.339	1356.98
BBR-B6	-6.762	-6.277	1469.36
BBR-B5	-6.372	-6.466	1561.84
BBR-B4	-5.955	-6.704	782.54
BBR-B3	-5.195	-6.553	997.40
BBR-B2	-4.352	-6.357	2045.21
BBR-B1 (base)	-3.664	-5.936	2203.72

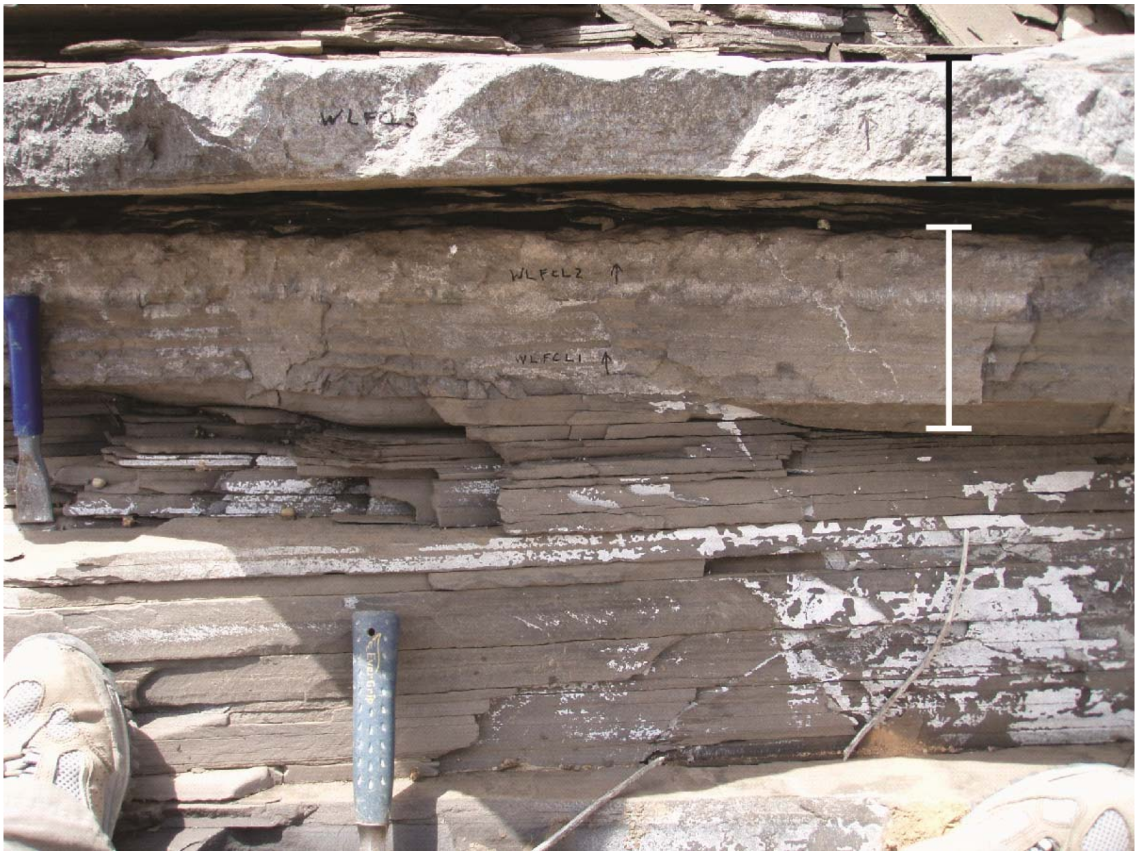

Figure DR1. Field photograph of formerly-aragonite fan layers from Williston Lake; one thick fan bed (black bar) and a fan bed-bearing interval (white bar). Chisel for scale.

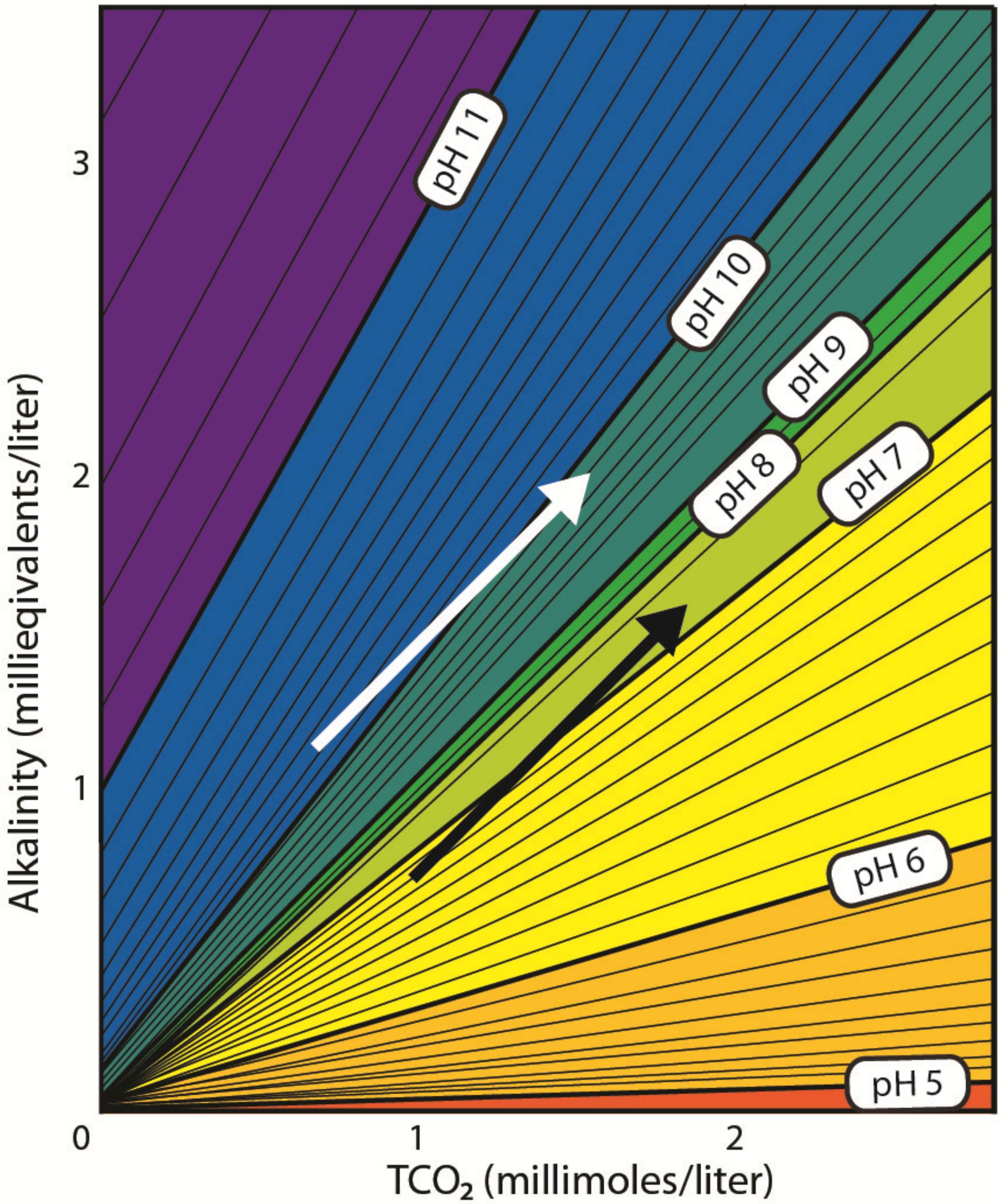

Figure DR2. pH space as a function of alkalinity and TCO_2 demonstrating the effect of sulfate reduction on pH. Radiating lines are lines of equal pH. Although sulfate reduction in a closed system will always increase the overall alkalinity of the system, it is not always beneficial for carbonate production. Sulfate reduction yields bicarbonate (HCO_3^-) as a byproduct: $SO_4^{2-} + 2CH_2O \rightarrow 2HCO_3^- + H_2S$. Bicarbonate is a component of both alkalinity and TCO_2, thus sulfate reduction changes porewater pH along a 1:1 slope in the fan diagram (see arrows). Adding bicarbonate into a pore space will raise the pH (promote precipitation of calcium carbonate) if the initial pH is low (black arrow). When initial pH is high, sulfate reduction in a pore space will actually decrease pH (inhibit precipitation of calcium carbonate) (white arrow).

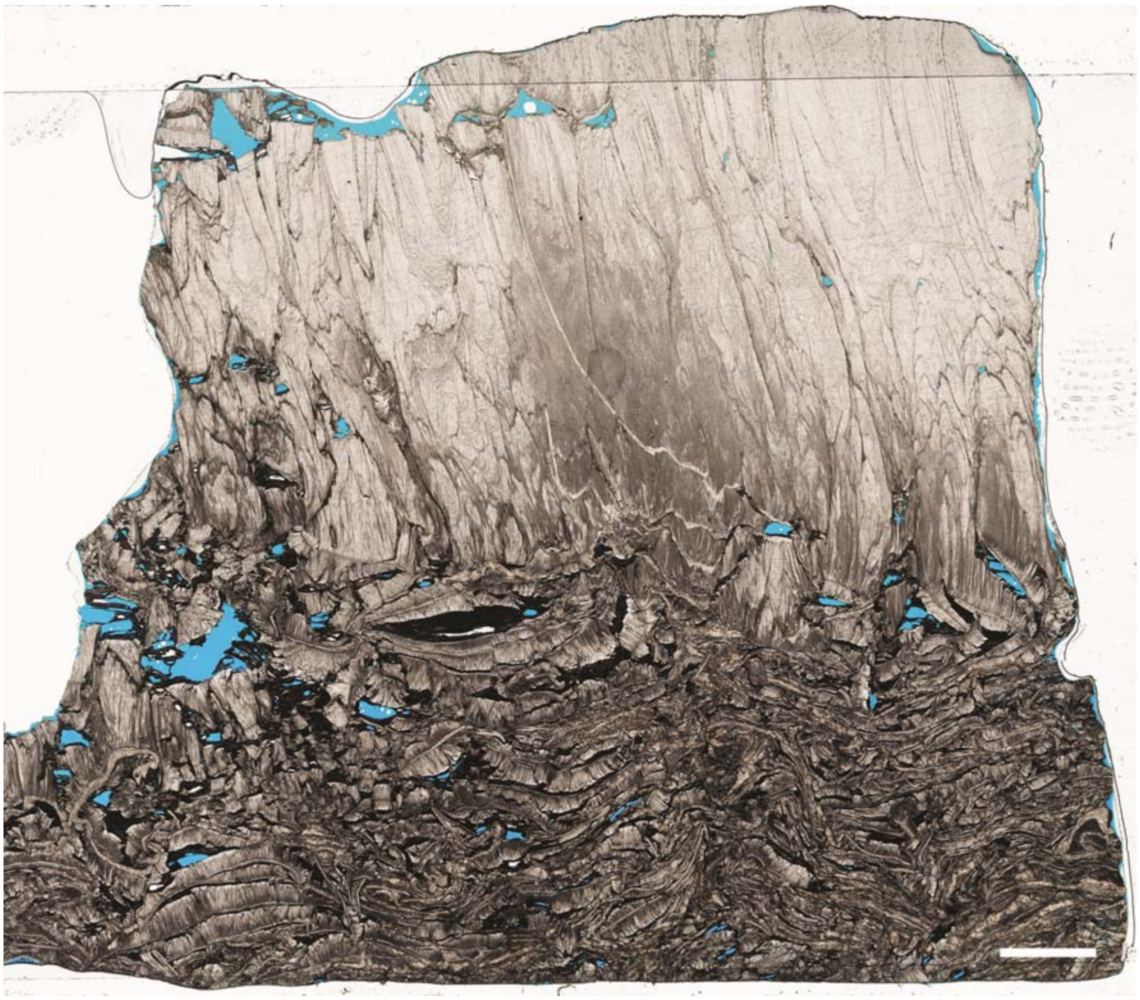

Figure DR3. Enlarged version of Figure 1E in text; scale 5mm.