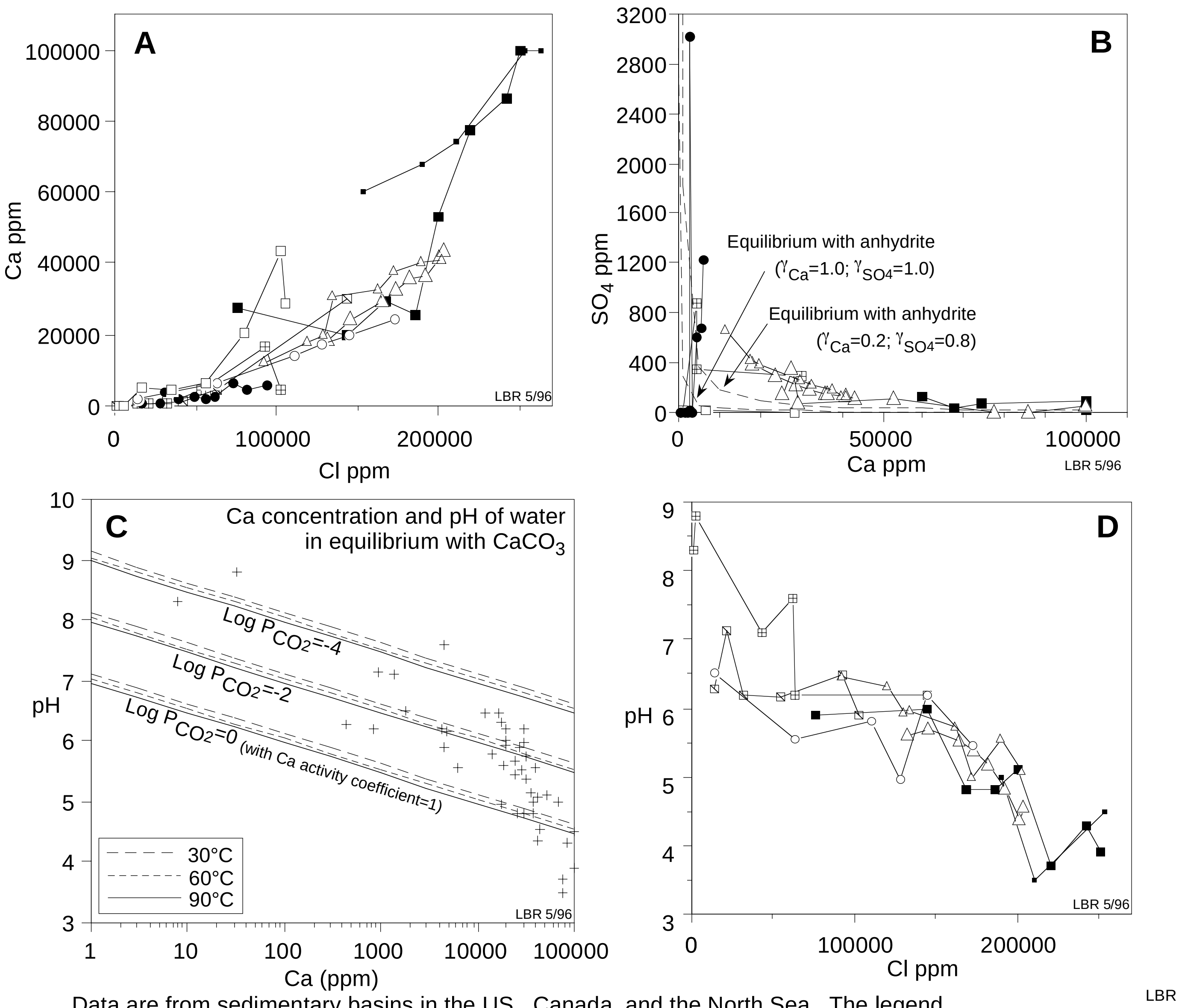
Deep-basin brines V: Effect of Ca^{2+}'s dominance on pH and SO_4^{2-} concentration

The huge increase in concentration of Ca^{2+} with Cl^-, and thus with TDS, in deep-basin brines (Plot A) has major ramifications for the chemistry of these brines. Ca^{2+} concentration and SO_4^{2-} concentration can vary independently so long as their product is less than the K_{sp} for anhydrite (i.e., so long as the solution is undersaturated with respect to anhydrite). Beyond that point, the requirement that the product of Ca^{2+} concentration and SO_4^{2-} concentration remains a constant (the K_{sp} for anhydrite) means that, as Ca^{2+} concentration increases, SO_4^{2-} concentration must decrease. The very high Ca^{2+} concentration in the most saline brines thus dictates proportionately low SO_4^{2-} concentrations (Plot B).

The same effect happens with Ca^{2+}, CO_3^{2-}, and calcite. The requirement that the product of Ca^{2+} concentration and CO_3^{2-} concentration remains a constant (the K_{sp} for calcite) means that, as Ca^{2+} concentration increases, CO_3^{2-} concentration must decrease. As CO_3^{2-} is driven from solution at high Ca^{2+} concentration, HCO_3^- dissociates, so that HCO_3^- concentration decreases too (as seen in Part IV of this series). With the removal of both CO_3^{2-} and HCO_3^- from solution, and thus the loss of most alkalinity, pH decreases to remarkably low levels (as is shown in Plots C and D below).



Data are from sedimentary basins in the US., Canada, and the North Sea. The legend for the symbols is shown on "Deep-basin brines I: Density, TDS, and chloride".