crystals precipitated in the current experiments are in agreement with these results (Fig 2). In the present study we show that the addition of the antiscalant also affects the crystals. Crystals precipitated from similar compositions become larger and more tabular (i.e., crystals have a shorter length to width ratio) when precipitated from solutions containing the antiscalant. In addition, fewer crystals precipitate in the presence of the antiscalant. This effect is increased with an increase in RF. In solutions containing 55% DS crystal habit and size is distinctly different when the complementary 45% is DRB or ESW, with crystals precipitated from the DS-DRB mixture being more tabular and larger. However, when the component of DS is increased to 90% there is no clear difference in habit between crystals precipitated from DS-ESW mixtures and those precipitated from DS-DRB mixtures (Fig 2). Alteration of gypsum morphology is dependent on the concentration of the additives that alter its morphology [9]. Furthermore, antiscalant reduces the number of crystals that develop [10]. For a specific composition, a mixture of DS with either DRB or ESW has the same precipitation potential. As RF is increased, the total amount of precipitate is distributed onto relatively fewer crystals. This together with the increased antiscalant concentration causes the reduction in the number of crystals while they become larger and more tabular.

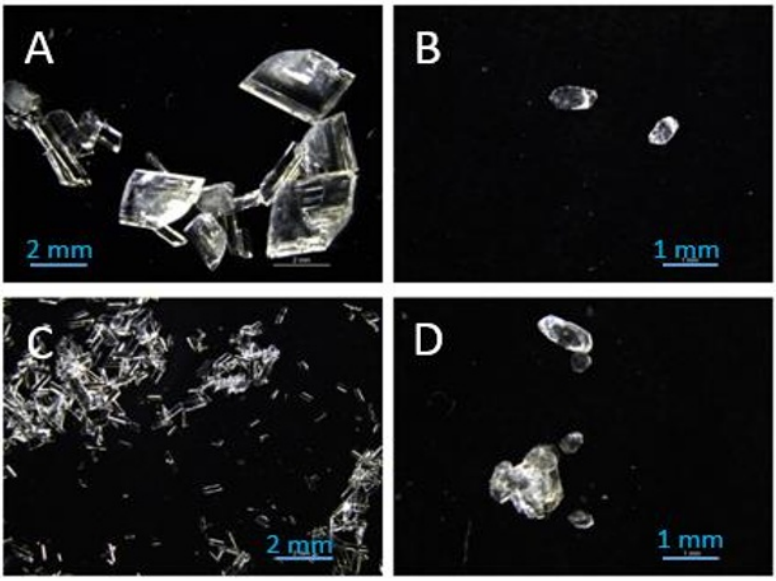

Fig. 2. Gypsum crystals precipitated from solutions of A) 55% DS + 45% DRB, B) 90% DS +10% DRB, C) 55% DS + 45% ESW and D) 90% DS + 10% ESW. Note that there are fewer crystals that become larger and more tabular in the solutions containing 55% DS when antiscalant is added.

Figure 3 presents the change of SO_4^{2-} concentration with time in both seeded and unseeded experiments. In all of the unseeded experiments once gypsum precipitation was determined, based on T_{ind}, the concentration of SO_4^{2-} declined faster in the DS-ESW solution compared to the DS-DRB solution of similar composition. The difference in rate [mol/kg/day] between the DS - DRB or ESW were increased as the % DS in the solution decreased from a factor of 1.14 to a factor of 3 (90% and 55% DS respectively). Phosphonate antiscalants inhibit precipitation by adsorbing onto the mineral surfaces [10]. Different crystal faces of a mineral have different surface properties such as density of reactive sites. A change in crystal morphology, as is seen in the various DS – ESW mixtures can therefore alter the ability of an antiscalant to adsorb onto the mineral. This needs to be considered along with the change in solution composition and properties of the antiscalant when assessing the fate of gypsum in the DS. However, in seeded experiments the changes of SO_4^{2-} in time were independent of the presence of the antiscalant

(Fig 3). This trend was found in all seeded experiments. Thus, regardless of the composition of the solution the ability or lack of it of the antiscalant to inhibit crystal growth is a function of the surface area available for growth.

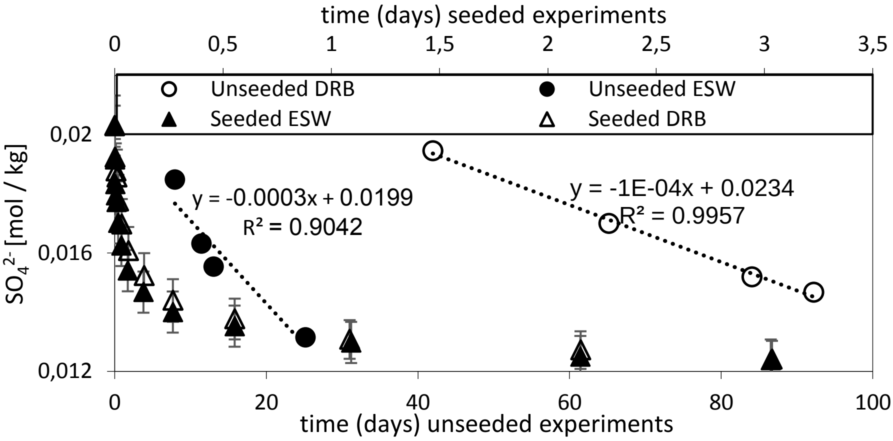

Fig. 3. Change in SO_4^{2-} concentration with time in experiments in which 55% DS was mixed with 45% SWE (Solid) and DRB (open). Circles are unseeded experiments and triangles are seeded experiments. Slopes of the plots for the unseeded experiments represent the precipitation rate of gypsum (mol/kg/day).

The annual volume of DRB which is proposed to be dumped into the lake during the pilot is of the same order of magnitude as the volume of the Lisan Bay (~$400*10^6$ m^3) on the south eastern shore, into which it is going to be discharged. Depending on the rate of exchange of the water in the bay, it is possible that the composition of the water there, at least for a certain time period, would be within the range covered by the experiments performed in this study. Eventually the composition in the bay would be determined by the discharge rate of DRB into the bay, the rate in which the two end members mix and the dynamics of flow between the bay and the lake at large. The range of T_{ind}, antiscalant efficiencies and crystal morphologies found here thus demand further research on the dynamics of the lake if an accurate prediction as to precipitation kinetics and morphology is to be provided.

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