

SCALE INHIBITOR ADSORPTION AND PRECIPITATION IN CARBONATES

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Introduction:

One of the most effective measures for avoiding the formation of mineral scale is to prevent its deposition by the use of chemical scale inhibitors (SI). These inhibitors are usually applied in the near-well formation by means of a "squeeze" treatment. In scale inhibitor squeeze treatments, the two main mechanisms of scale inhibitor retention are recognised to be adsorption (Γ), precipitation (π) or a combination of the two, i.e. coupled adsorption / precipitation (Γ / π).

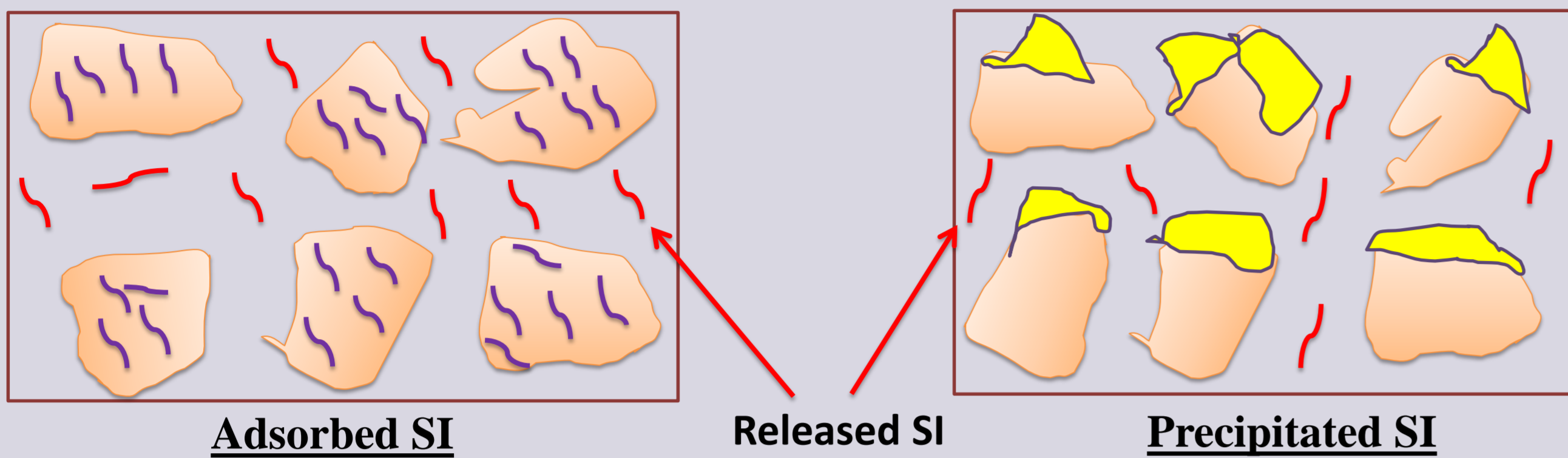


Figure 1. Scheme of two main retention mechanism in reservoirs

As about 50% of the world's oil production is from carbonate formations, understanding the chemistry behind the mode of retention of the inhibitors within carbonate formations is an important issue.

The aim of the work is to investigate the most important mechanisms governing the retention of different scale inhibitors (DETPMP and VS-Co as representatives of phosphonate and polymeric scale inhibitors, respectively) in carbonate porous media. This has been done by carrying out a range of "apparent adsorption" experiments where we plot the apparent adsorption, Γ_{app} , vs. C_f , the final SI concentration. In particular, we study the precipitates using ESEM/EDAX and also particle size analysis (PSA).

Theory behind Adsorption/Precipitation Mechanism:

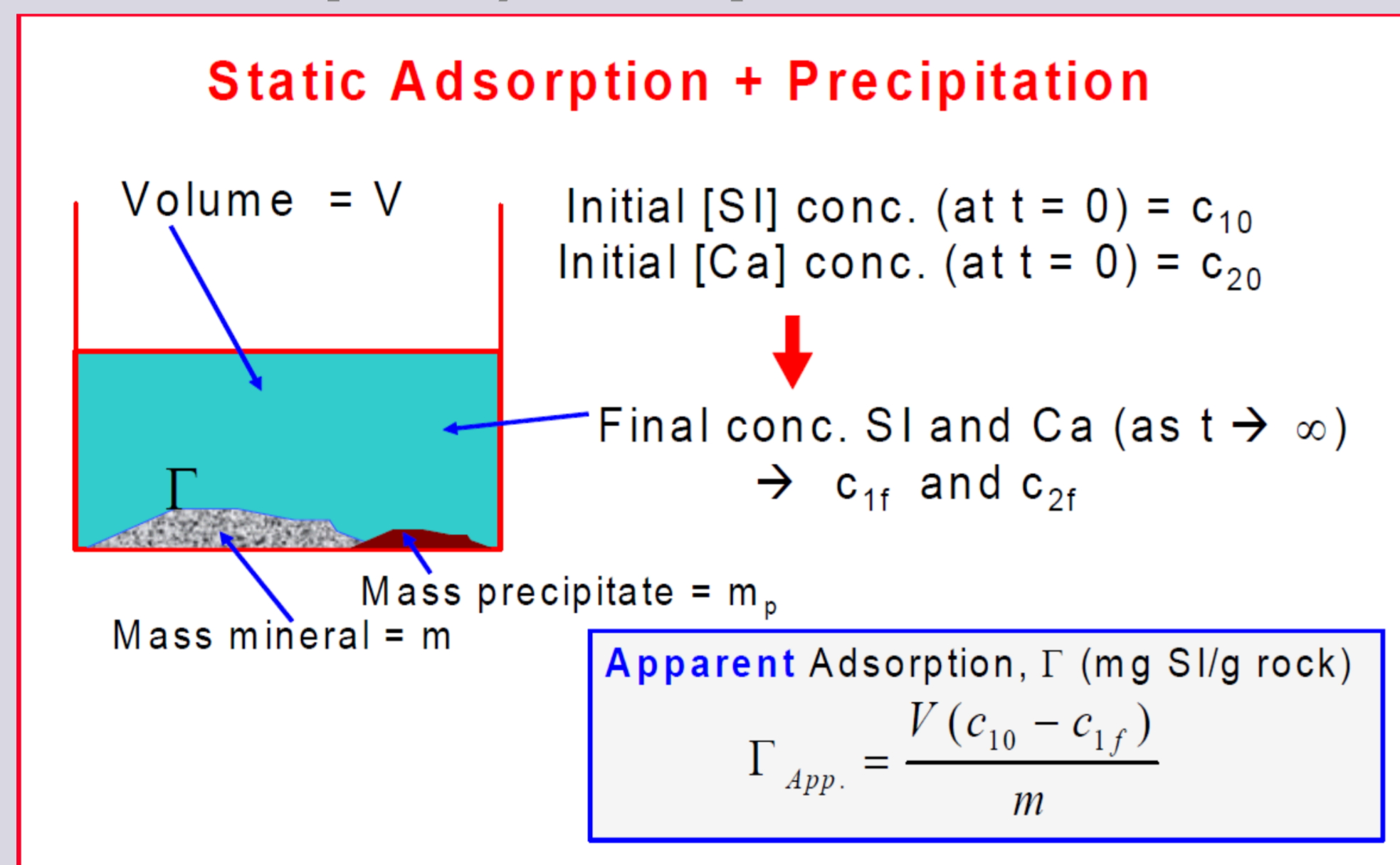


Figure 2. Scheme of coupled adsorption and precipitation

Experimental Results:

DETPMP, VS-Co -Calcite Adsorption/Compatibility Test:

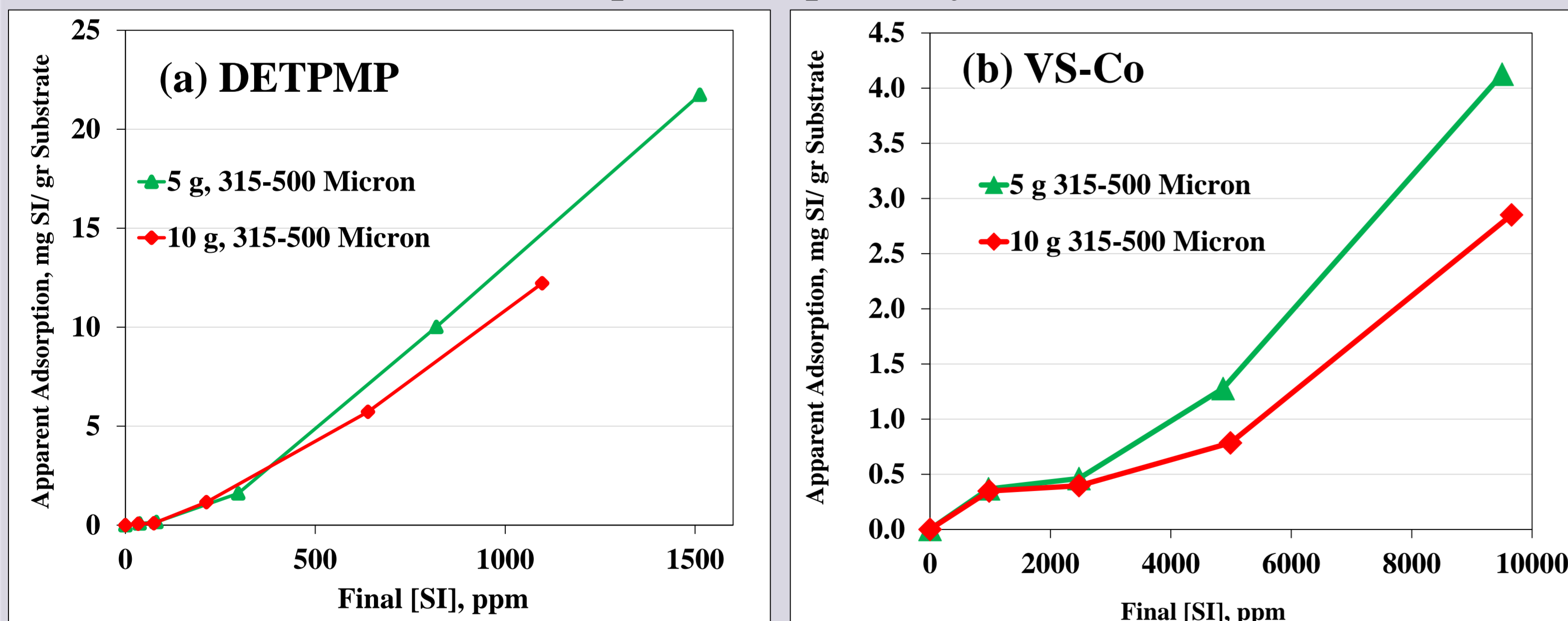


Figure 3. Apparent adsorption for a) DETPMP and b) VS-Co onto 2 masses of calcite

Although both pure adsorption (Γ) and coupled adsorption precipitation (Γ / π) regions are observed for both scale inhibitors, precipitation is more dominant for DETPMP/Carbonate retention while pure adsorption is more dominant for the VS-Co/Carbonate system. These differences between DETPMP and VS-Co in their behaviour with calcite is due to the different SI-Ca binding strengths of the different functional groups present in each of these SIs.

Sponsors:



ESEM/EDAX Analysis for DETPMP, VS-Co/ Calcite:

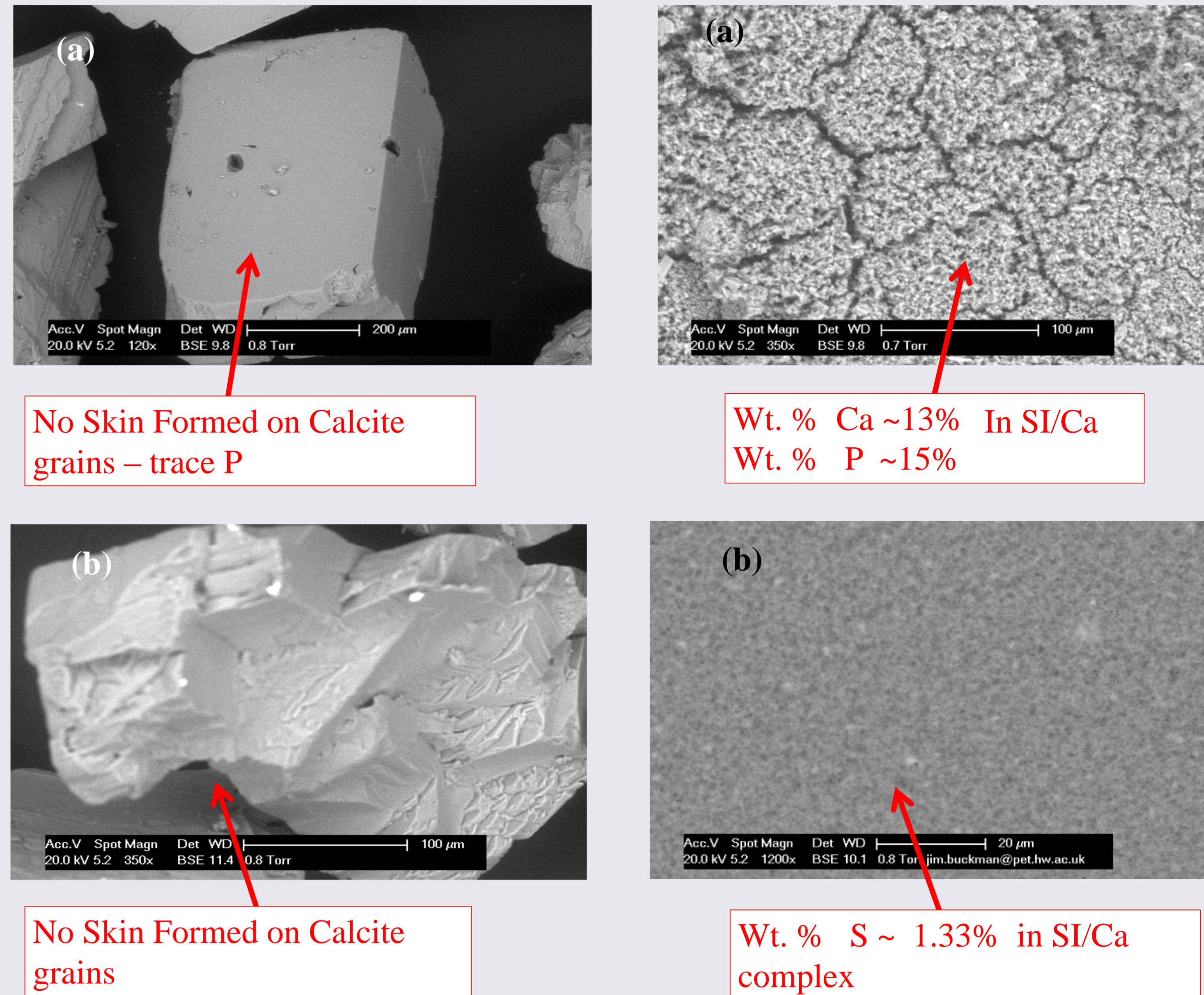


Figure 4. Morphology of a) DETPMP and b) VS-Co Samples for calcite on ESEM photographed samples

As illustrated in Figure 4 (a), phosphorous is clearly detected at a high level (~13% by weight) in the finer precipitate which forms in bulk mainly on the filter paper for the 2000ppm DETPMP case. However, some small amount of sulphur on the calcite grain can be detected for 10000ppm VS-Co (Figure 4 (b)) but we cannot say with certainty whether it is related to VS-Co as there are 2 sources of sulphur; seawater and VS-Co.

Particle Size Analysis for DETPMP and VS-Co/Calcite:

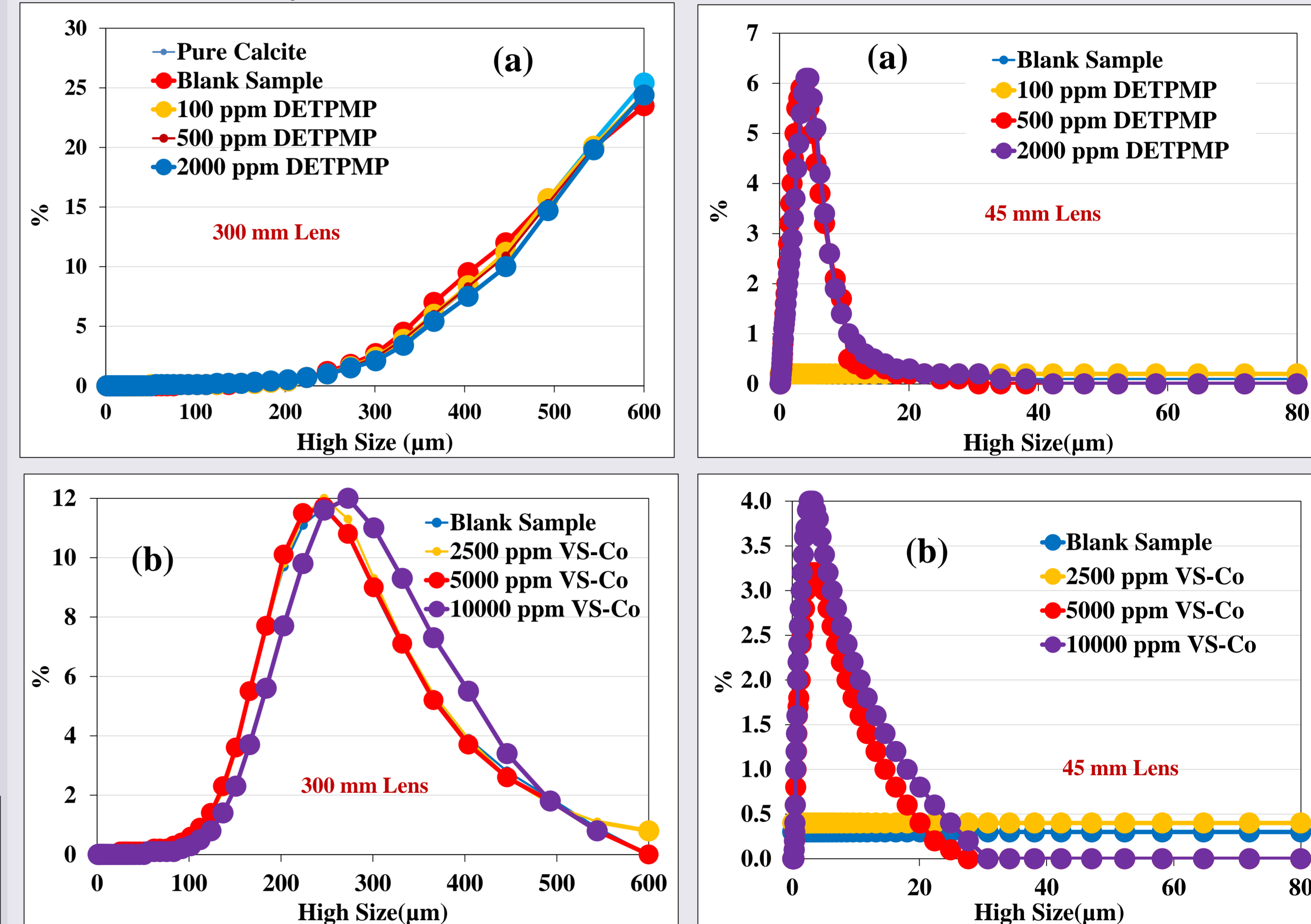


Figure 5. Particle Size Analysis for a) DETPMP and b) VS-Co/ calcite residue in different concentrations with 300 and 45 mm lens

These PSD results in Figure 5 (a) show that there is good consistency in the measurement of particle size with the largest 300mm lens. For these cases (pure calcite and 100ppm DETPMP), we see that only large particle sizes are observed broadly in agreement with the calcite size range we expect. When these same samples (pure calcite and 100ppm DETPMP) were examined by the smaller lens (45 mm lens) which can see much smaller particles (from ~1 - 20 mm), we see no fine particles of this size. Moreover, Using the smaller (45 mm) lens, then smaller particles can be detected if they are present, as shown in Figure 5 (b) for VS-Co case.

Conclusion:

- Precipitation more dominant is for DETPMP/carbonate retention while is Adsorption more dominant for VS-Co (but both Γ and π observed).
- Differences between DETPMP and VS-Co with Carbonate is due to different functional groups and sequently different strengths of SI - Ca binding.
- ESEM results : No surface coating on the calcite was observed. In addition, based on EDAX analysis , for DETPMP , a significant amount of phosphorus (P) and Ca was detected while for VS-Co, only at high levels of [Vs-Co] ~10000ppm, precipitate VS-Co/Ca was observed.

Acknowledgments:

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