Small Shelly Fossil-Style Preservation from the Lower Triassic Virgin Limestone Member of the Moenkopi Formation, Lost Cabin Springs Locality, Western US

MAXWELL, Vivienne[1]; THUY, Ben[2], and PRUSS, Sara[1]

(1) Department of Geosciences, Smith College, Northampton, MA 01063; (2) Department of Palaeontology, Natural History Museum Luxembourg, Luxembourg City, Luxembourg

Introduction

- Seven samples in subtidal settings preserved at Lost Cabin Springs (Figs. 1,2)
- Yielded gastropods, brachiopods, ophiuroid elements, echinoid spines, rare ostracods and bivalves, and crinoids (Figs. 3, 4)
- Fossils in the smallest size fraction (< 1000 μm) preserved by apatite (Figs. 5, 6)
- Crinoid ossicles in larger size fraction (1000 μm < ~2500 μm) replaced or molded by silica and dolomite (Figs. 4 - 6)
- Similar early diagenetic conditions led to different styles of preservation
- Supports notion that there is size selectivity in phosphatization (e.g., Creveling et al., 2014; Pruss et al., 2018)

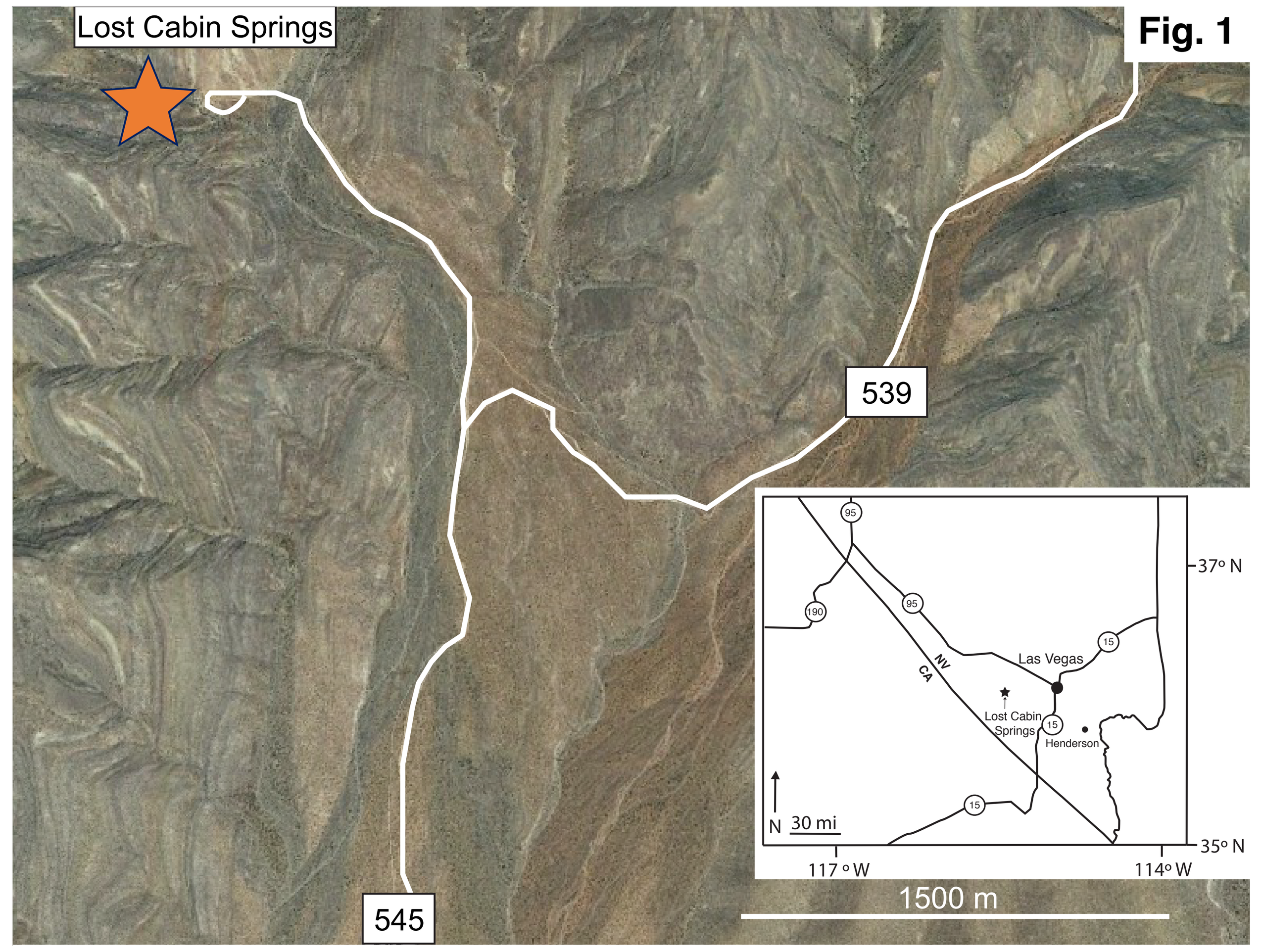

Fig. 1: Lost Cabin Springs Locality in Southern Nevada, ~30 miles west of Las Vegas

Methods

- Dissolved nine samples in 200-400mL of 10% glacial acetic acid solution buffered with ammonium acetate
- Sieved and collected insoluble residues >400 μm, >250 μm and >177 μm size fractions
- Seven samples (Fig. 2) produced abundant fossils in insoluble residues, which were imaged with the FEI Quanta 450 Scanning Electron Microscope (SEM)
- Individual fossils (n = 121) were measured along their long axis to determine the range of sizes for each taxonomic group (Fig. 5)
- Elemental composition of the fossils was analyzed using EDS (Energy Dispersive Spectroscopy) Team software (Fig. 6)

Results

- Ophiuroid elements, gastropods, brachiopods, echinoid spines, rare ostracods and bivalves were < 1000 μm, whereas crinoids were >1000 μm (Fig. 5)
- Ophiuroid elements, gastropods, brachiopods, echinoid spines, and rare ostracods were phosphatized, confirmed by EDS (Fig. 6A,C)
- Calcium-Fluorapatite was present in several ophiuroids, brachiopods and gastropods and rare bivalves (Fig. 6A)
- EDS analysis of the larger crinoids (>1000 μm) suggest that these fossils were primarily replaced by silica, with minor dolomite (Fig. 6B)

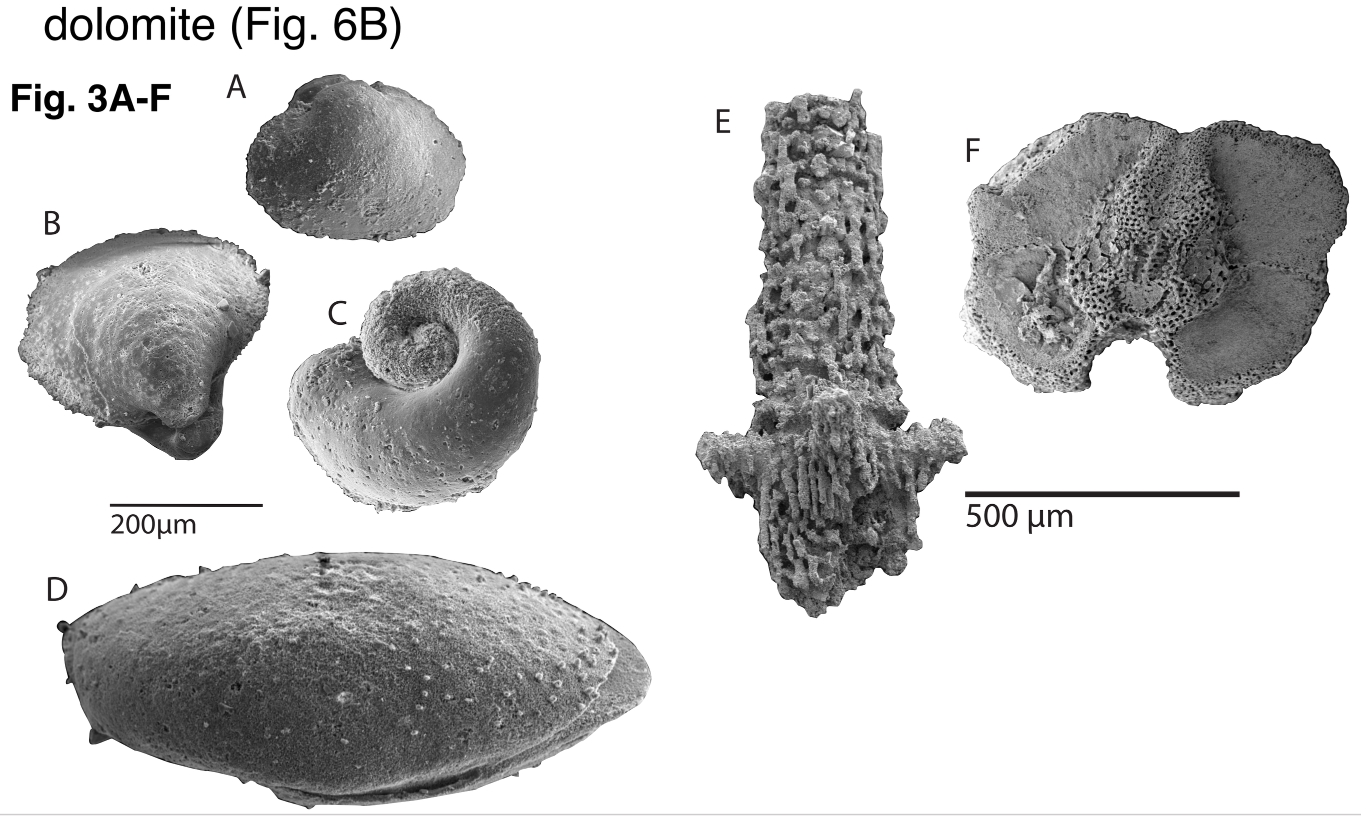

Fig. 3: New assemblage of Small Shelly Fossil-Style Preservation from Lost Cabin Springs Locality in Southern Nevada
3A: Bivalve, 3B: Brachiopod, 3C: Gastropod, 3D: Ostracod, 3E: Echinoid Spine, 3F: Ophiuroid element

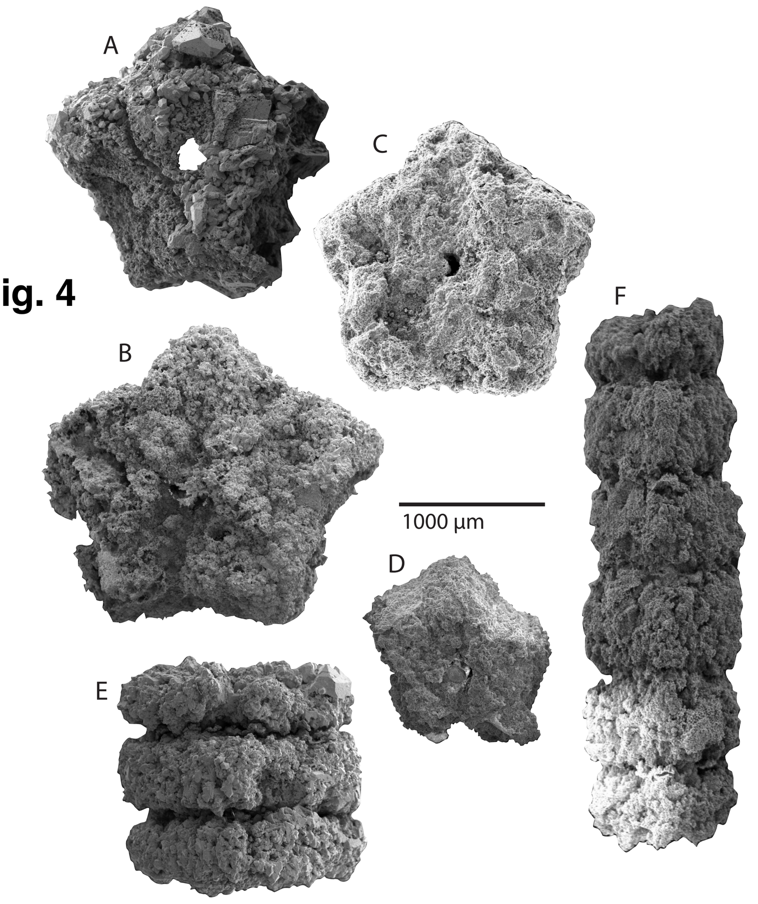

Fig. 4: Silicified Crinoid ossicles (A-D) and stalks (E, F)

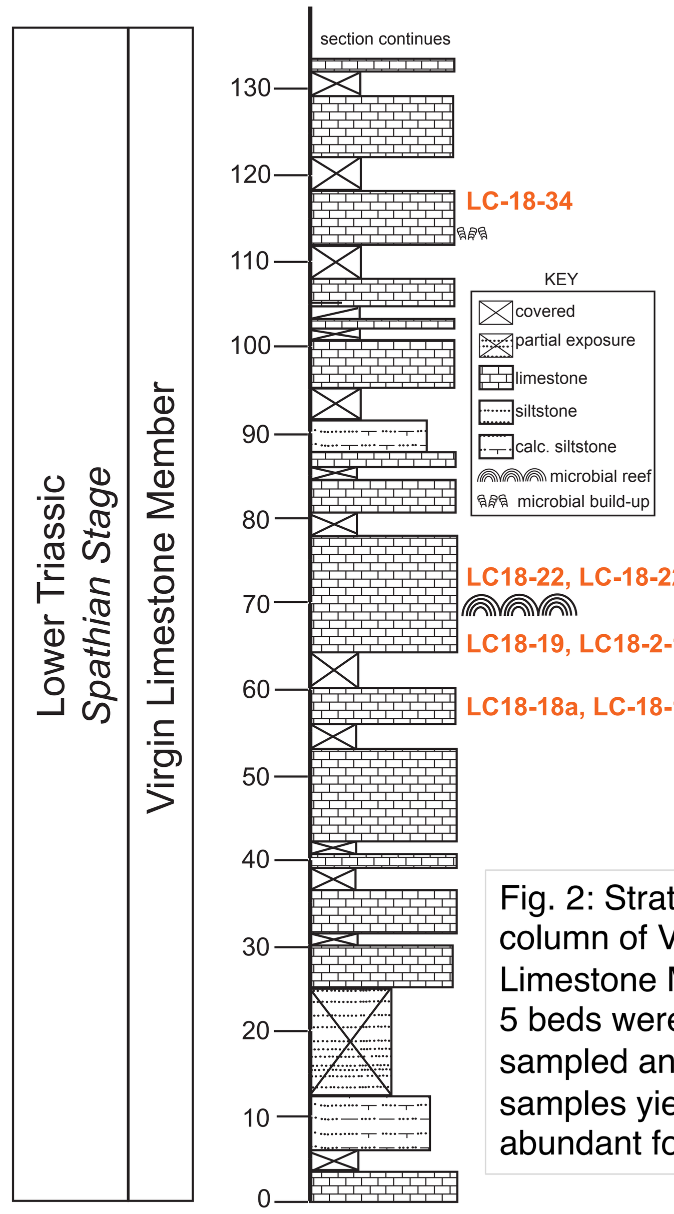

Fig. 2: Stratigraphic column of Virgin Limestone Member. 5 beds were sampled and 7 samples yielded abundant fossils.

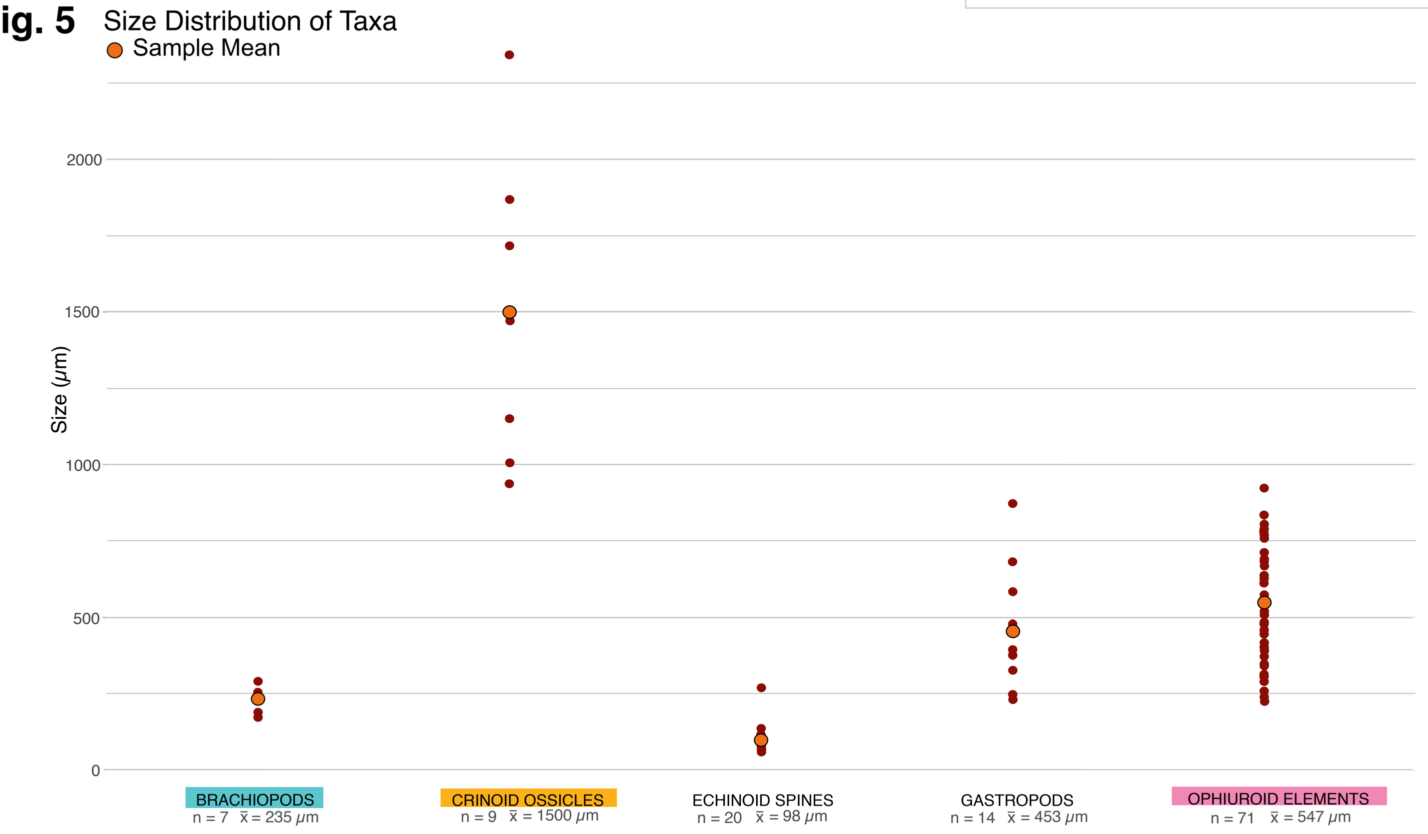

Fig. 5: Dotplot of size distribution for the various taxa. Brachiopods, echinoid spines, gastropods, and ophiuroid elements < 1000 μm. Crinoid ossicles were between 1000 μm and 2500 μm.

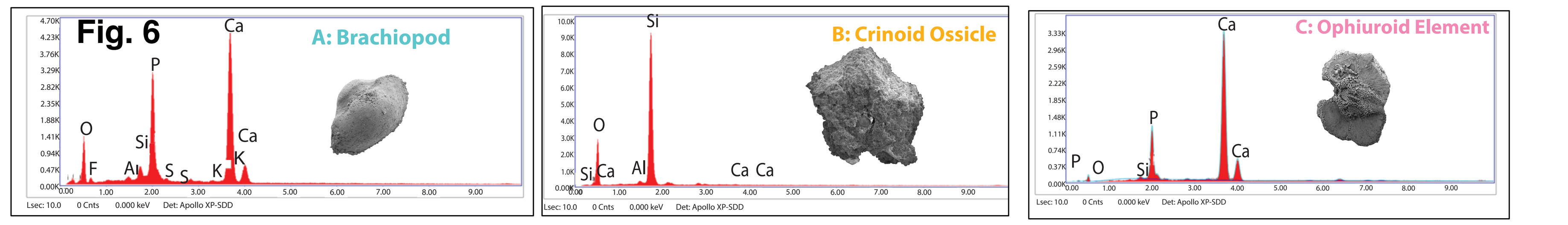

Fig. 6: EDS analysis; 6A: Calcium-Fluorapatite brachiopod, 6B: Silicified crinoid ossicle, 6C: Phosphatized ophiuroid element

Discussion and Conclusion

- Size is the strongest predictor of phosphatization in the Virgin Limestone assemblage at Lost Cabin Springs.
- Fossils in the smallest size fractions (<1000 μm), were phosphatized, confirmed by EDS (Figs. 5, and 6A,C).
- Crinoids replaced by silica and dolomite were all 1000 μm < 2500 μm (Figs. 5, and 6B).
- We suggest the combination of small shell size and pore water as underlying mechanisms of phosphatization.
- Early Triassic ocean is characterized as having exceedingly warm water temperatures (e.g., Sun *et al.* 2012).
- We propose that this warm environment combined with local pore water redox controls on the sediment resulted in accumulation of phosphorus and the formation and preservation of small shelly fossils.

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