doi: 10.2110/sedred.2019.1
Volume 17, No. 1, March 2019

The SEDIMENTARY Record

A publication of SEPM Society for Sedimentary Geology
with the Sedimentary Geology Division of GSA

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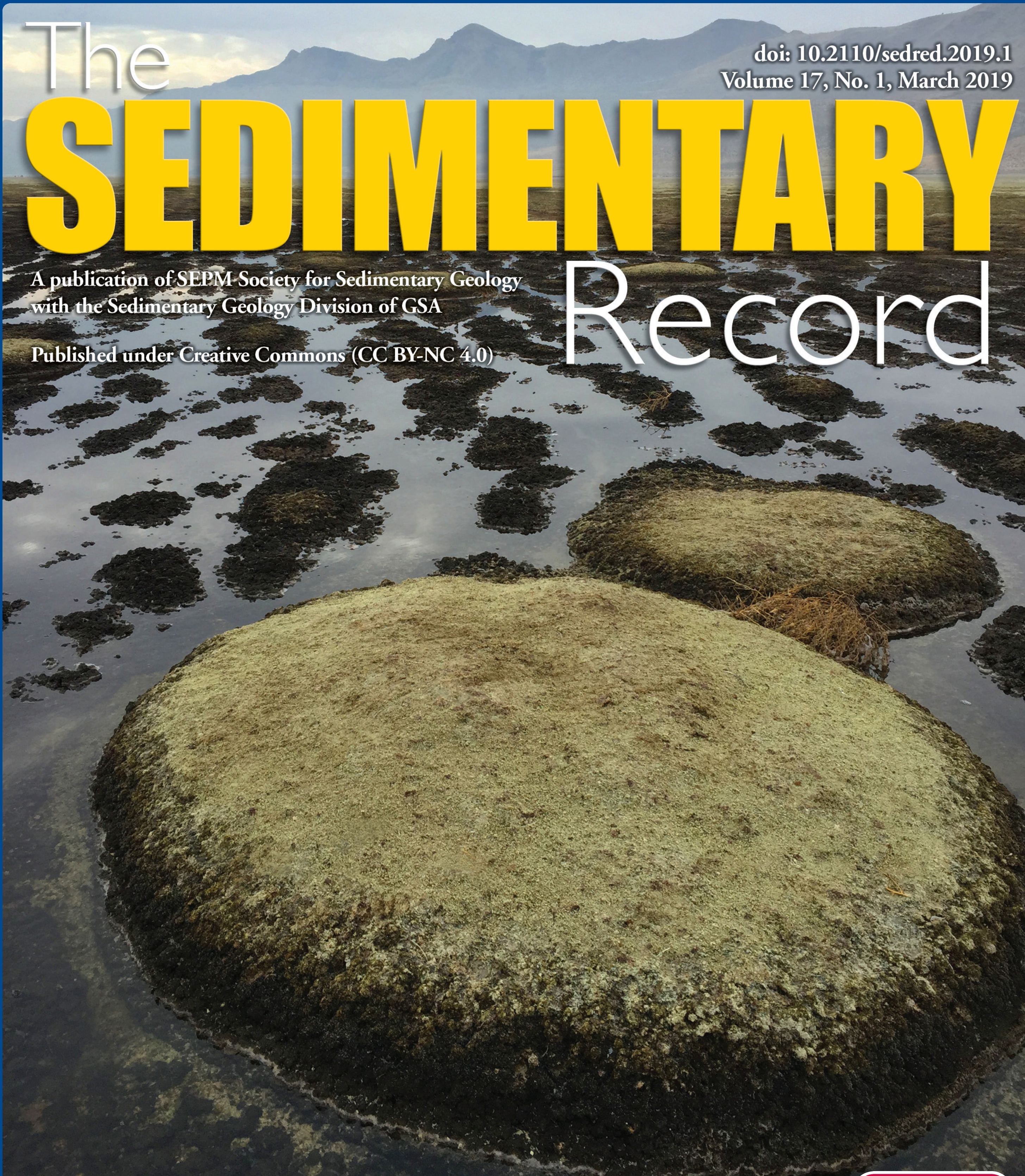

INSIDE: DOMES, RINGS, RIDGES, AND POLYGONS: CHARACTERISTICS OF MICROBIALITES FROM UTAH'S GREAT SALT LAKE

PLUS: PRESIDENT'S COMMENTS, SGD NEWS, SEPM ANNUAL MEETING EVENTS AT ACE – SAN ANTONIO

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Special Publication #109

Characterization and Modeling of Carbonates— Mountjoy Symposium 1

Edited by: Alex J. MacNeil, Jeff Lonnee, and Rachel Wood

In August of 2015 the first Mountjoy Carbonate Conference, co-hosted by the Society for Sedimentary Geology (SEPM) and Canadian Society of Petroleum Geologists (CSPG), took place in Banff, Alberta. As the approaches to characterization and modeling of carbonate reservoirs are undergoing rapid changes, this was the theme of the meeting. This Special Publication, following the inaugural meeting, contains nine state-of-the art papers relating to the (1) characterization of carbonates and advances in analytical methods, (2) controls on carbonate reservoir quality and recovery factors, and (3) reservoir distribution, the modeling of dolostone geobodies, and reservoir prediction. The Introduction includes an overview of Eric Mountjoy's career and his many contributions to the science. The contents of this Special Publication should be useful to those engaged in the characterization and modeling of carbonate reservoirs, including unconventional carbonate reservoirs, and is highly recommended as one of the most impactful recent publications for those working in this area of sedimentary science.

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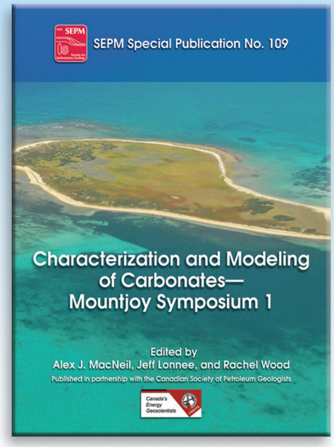

Concepts in Sedimentology and Paleontology 9 (2nd edition)

Sequence Stratigraphy of Siliciclastic Systems

Edited by: Vitor Abreu, Howard R. Feldman, Keriann H. Pederson, and Jack E. Neal

This publication is the result of more than 3 decades of sequence stratigraphy research and application. The objective is to emphasize the most important aspects of Sequence Stratigraphy—a method to guide geologic interpretation of stratigraphic data (seismic profiles, well-logs, cores and outcrops) across scales (from local to regional and global) and depositional environments (from continental to deep marine).The stratigraphic concept of a depositional sequence was introduced to the scientific literature by Peter Vail and his colleagues in the late 70s, building on the shoulders of giants like Chamberlain, Sloss and Wheeler. Since then, several papers compared and contrasted the original sequence-stratigraphic school published in the AAPG Memoir 26 in 1977 with other approaches to subdivide the geologic record, as well as, debating the model validity and impact on the community. At its core, the "model" is really a stratigraphic interpretation method, which was never explicitly documented in the literature. The objective of this book is to present the sequence stratigraphic method in its current form in an attempt to clarify its usage and application in diverse geologic data and depositional environments. This publication is the result of more than 3 decades of sequence stratigraphy research and application. The objective is to emphasize the most important aspects of Sequence Stratigraphy—a method to guide geologic interpretation of stratigraphic data (seismic profiles, well-logs, cores and outcrops) across scales (from local to regional and global) and depositional environments (from continental to deep marine). This book in an 11 x 17 format is designed to be easily used for teaching or self-learning experiences. In the second edition of the "Atlas", the book was divided in 2 separately bound volumes—Exercises and Solutions—to make it easier to use the publication as text book for sequence stratigraphy courses in universities. Also, a new exercise was added and several of the existing exercises went through major updating and editing.

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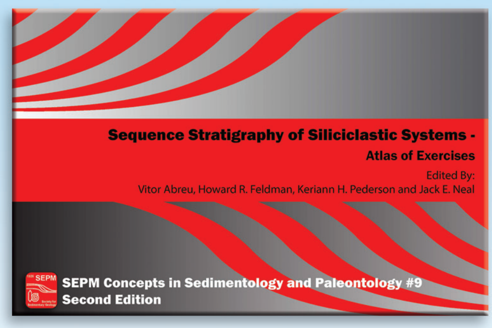

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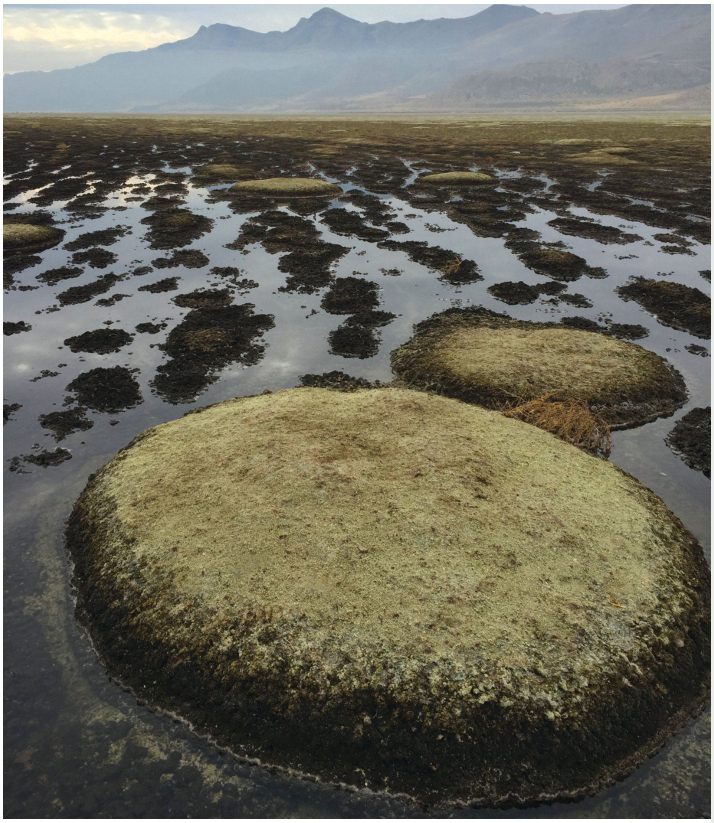

Cover image: Large, well-cemented microbialite dome (foreground, about 3 m in diameter) near the northeastern tip of Stansbury Island, Great Salt Lake, Utah. The low lake level and exposure has caused the microbial mat (dark brown) on the top of the dome to die and erode, exposing the light gray carbonate below. Surrounding the single domes are low-relief, elongate (parallel to dominant wave direction) microbialites. Photo by Michael Vanden Berg.

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The Sedimentary Record (ISSN 1543-8740) is published quarterly by the Society for Sedimentary Geology with offices at 1621 S. Eucalyptus Ave., Suite 204, Broken Arrow, OK 74012, USA.

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The Sedimentary Record is provided as part of membership dues to the Society for Sedimentary Geology.

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Domes, Rings, Ridges, and Polygons: Characteristics of Microbialites from Utah's Great Salt Lake

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INTRODUCTION

Two recent events have put Great Salt Lake (GSL) in northern Utah at the forefront of microbialite research. First, massive oil accumulations were discovered in the mid-2000s in offshore South Atlantic "pre-salt" deposits of Cretaceous lacustrine carbonates, including purported microbialites. Petroleum geologists working the pre-salt reservoirs fanned the globe looking for analogs to better understand lacustrine systems and the unique highly permeable and porous deposits called microbialites. At about the same time, GSL experienced record low levels not seen since the early 1960s, exposing one of the world's largest Holocene accumulations of lacustrine microbialites. As a result, GSL quickly became a must visit locale for petroleum geologists.

In light of this new international interest, researchers have sought to better understand GSL microbialites-their age, formation mechanisms, distribution, and relationship to other lake facies. This paper provides an introduction to the basic morphology of these unique structures and how local environmental conditions, as well as periods of exposure and erosion, contribute to growth location, grouping, shape, size, orientation, and internal structure. Several other research groups are exploring other important aspects including mineral precipitation mechanisms (Bouton et al., 2016; Pace et al., 2016), biogeochemistry/microbiology (Lindsay et al., 2016; Baxter, 2018), and possible age of formation and paleoenvironmental record (Newell et al., 2017; Vennin et al., 2019).

BACKGROUND

GSL is the remnant of Pleistocene (32-12 ka) Lake Bonneville, which covered 52,000 km^2 of northwestern Utah as well as small parts of northeastern Nevada and southeastern Idaho (Gwynn, 1996). Lake Bonneville first retreated due to a catastrophic flood into the Snake River Plain, but then the changing climate (warmer and drier) further reduced its size, leaving behind present-day, hypersaline GSL.

GSL averages 121 km long and 56 km wide, covering 4100 km^2, and fills the lowest depression in the terminal Bonneville basin (Fig. 1). The volume of water in the lake varies both annually and seasonally depending on catchment precipitation, whereas water loss is primarily due to evaporation (~3600 hm^3 per year; Gwynn, 1996). GSL surface elevation has fluctuated nearly 6 m over recorded history (since 1847), with a long-term elevation average of ~1280 m (4200 ft) above mean sea level (Fig. 1, inset). GSL is shallow, maximum depth is ~10 m, and has broad low-gradient shorelines (Fig. 1). These shallow nearshore areas are favorable for microbialite formation but are also subject to exposure as lake levels fluctuate.

In the late 1950s, a gravel-filled railroad causeway was constructed across the lake, isolating the north arm from the rest of the lake (Fig. 1). With none of the four major rivers entering the north arm, the salinity climbed to 24-26% (near halite saturation), whereas the salinity of the south arm is 12-14% and probably more representative of Holocene conditions.

Post-Bonneville Holocene lake level fluctuations are poorly understood (Murchison, 1989), but measured lake level records reach back to 1847 (Fig. 1, inset). With some exceptions, it is generally assumed that Holocene (since ~12 ka) and historic lake level fluctuations were similar in magnitude and frequency, notwithstanding the anthropogenic influences that have contributed to the more recent low lake level (Wurtsbaugh, 2016). One exception may be the warm/dry period during the mid-Holocene Climatic Optimum (~8-6 ka), in which the lake might have dropped to 6 m below the historic average (Murchison, 1989; Steponaitis, 2015).

Two previous decade long periods where lake levels receded below 1278.6 m (4195 ft), exposing the GSL microbialites, were initiated in 1935 and 1960 (Fig. 1, inset). Eardley (1938) provided the earliest definitive work on "algal bioherms" and associated deposits, including the importance of bacteria in their formation. Carozzi (1962) and Post (1980) described GSL "algal biostromes" and the precipitation of calcium carbonate by "blue-green algae," and Halley (1976) investigated the textural variations within GSL "algal mounds." As a result of the more recent low lake levels, Lindsay et al. (2016) researched the living microbial communities and their abilities to survive in a hypersaline environment, while Baskin (2014) attempted to characterize the lake-wide distribution and depth of GSL microbial "bioherms." In addition, Chidsey et al. (2015) and Della

Porta (2015) looked more closely at GSL microbialite characteristics and facies associations. Moreover, a possible older generation (~12 ka) of GSL microbialites are present at higher elevations (1281.7-1284.7 m, 4205-4215 ft; not further discussed). Examples include the well-lithified microbialites, with associated multi-meter-scale travertine mounds, near Lakeside (Homewood et al., 2018) and the heavily eroded remnants of microbialites near Rozel Point (Chidsey et al., 2015).

CHARACTERISTICS OF GSL MICROBIALITES

Basic Microbialite Characteristics

The spatial distribution of GSL microbialites, and their relationship to lake bathymetry (Baskin and Allen, 2005; Baskin and Turner, 2006), was estimated based on examination of Google Earth imagery as well as limited field mapping (Fig. 1). These boundaries will continue to be refined through additional field work. The morphology of GSL microbialites varies according to location. In low-energy areas, like sheltered Bridger Bay at the northern tip of Antelope Island, the microbialites range from nearshore, low-relief and poorly lithified circular “mats” (collapsed domes?, see below) (Fig. 2A), to deeper water, poorly lithified but higher relief domes, all averaging ~15-91 cm in diameter. In contrast, microbialites in higher energy areas, like the east side of Stansbury Island, can be much larger (including the largest domal structure found to date at ~3 m in diameter and ~2 m tall) and better lithified (Fig. 2B). Low-relief elongate microbialites are also present on the west side of the lake (Fig. 2B, structures surrounding the large dome). Images from several unmanned aerial vehicle (UAV) transects were used to better characterize GSL microbialite morphology by lake location and shoreline proximity. For example, figure 2C shows unique linear trends, perpendicular to wave direction, near the northern tip of Antelope Island. This high-resolution imagery shows that GSL microbialites, at least in Bridger Bay, are densest near an elevation of 1277.7 m (4192 ft). Compared to an average historic lake level of ~1279.6-1280.2 m (4198-4200 ft), this suggests that GSL microbialites prefer water depths of 1.8-2.4 m.

The microbialites in GSL are found in both the north and south arms (Fig. 1). Submerged microbialites in the south arm are covered with a green-brown, pustular microbial mat that is absent on the microbialites in the ultra-hypersaline north arm. During low lake levels, exposed north arm microbialites are covered with and encased in halite, as well as a thin crust of calcium carbonate (Fig. 2D). Based on analysis of microbes collected from the surface of GSL microbialites, Lindsay et al. (2016) concluded that the microbial communities found in the north and south arms are distinct. Significantly, the south arm structures contain more photoautotrophic taxa (the green-brown mats), which could drive carbonate precipitation, than are found on north arm microbialites. These observations suggest that all GSL microbialites were forming prior to causeway construction, in lake-wide chemical conditions similar to the present-day south arm. If the microbialites are still “growing” today, growth is limited to the south arm, and north arm microbialites are simply relict structures.

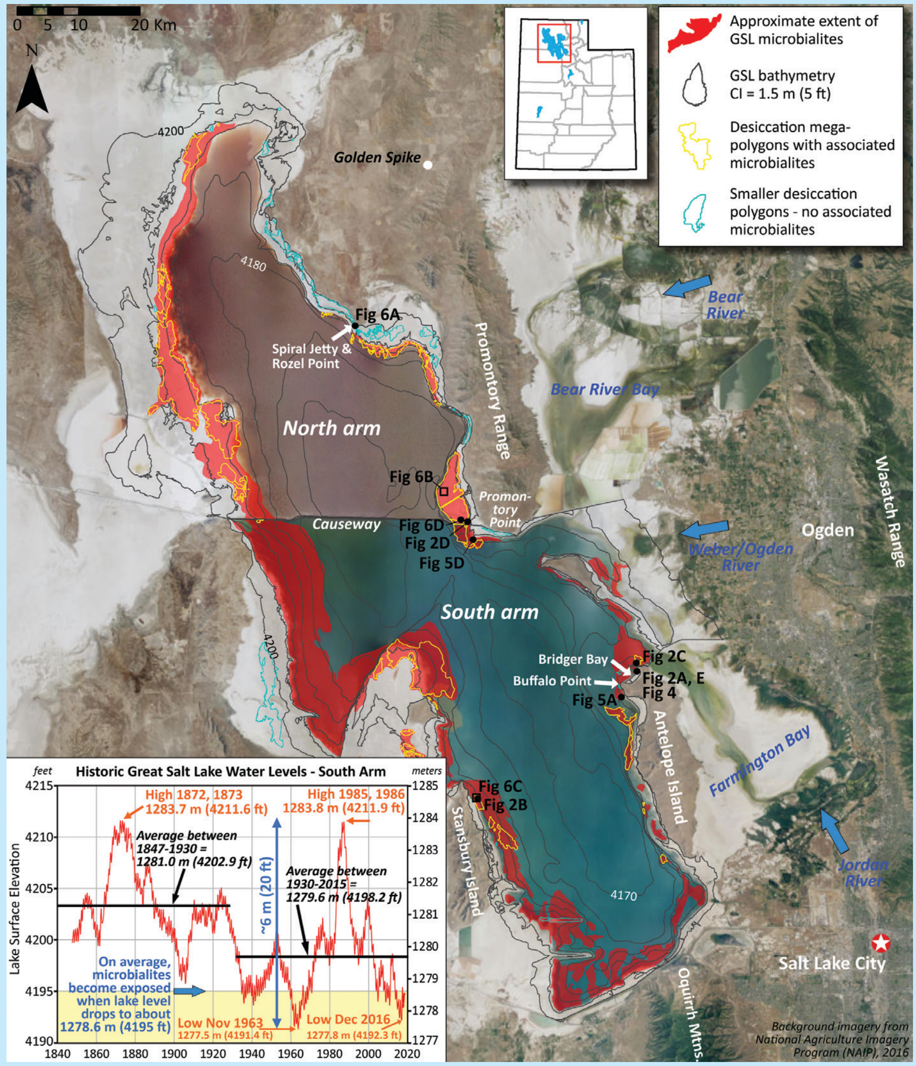

Figure 1: Aerial image of GSL and surrounding highlands from 2016 displaying estimated microbialite extent and areas with shrinkage polygons. Locations of photographs from subsequent figures are shown; lake bathymetry is from Baskin and Allen (2005) and Baskin and Turner (2006). The inset graph shows elevation of GSL through recorded history, 1847-2018 (USGS, 2019).

GSL microbialites are difficult to place into the traditional microbialite classification scheme of Riding (2000). Their internal composition is mostly structureless (leiolite?) (Fig. 2E), but some are composed of thick (7.6-15.2 cm), poorly defined layers (stromatolites?), but are definitely not finely laminated. Detailed micro-facies analysis of high-resolution photomicrographs (Fig. 3A) shows that these structures are mostly composed of captured grains (~40%, mostly carbonate grains [e.g., ooids and pellets] but sometimes up to 10% lithics) (Fig. 3B-C) and pore space (~30%, mostly interparticle pores and constructional vugs), with only ~30% of the structure composed of fibrous aragonitic microbial "clots" (thrombolite?) (Fig. 3A-B, 3D). The clots are the best indication of direct calcium carbonate precipitation from microbes as they mirror the microscopic box-work-like structure of the cyanobacteria in the living microbial mats (Fig. 3D).

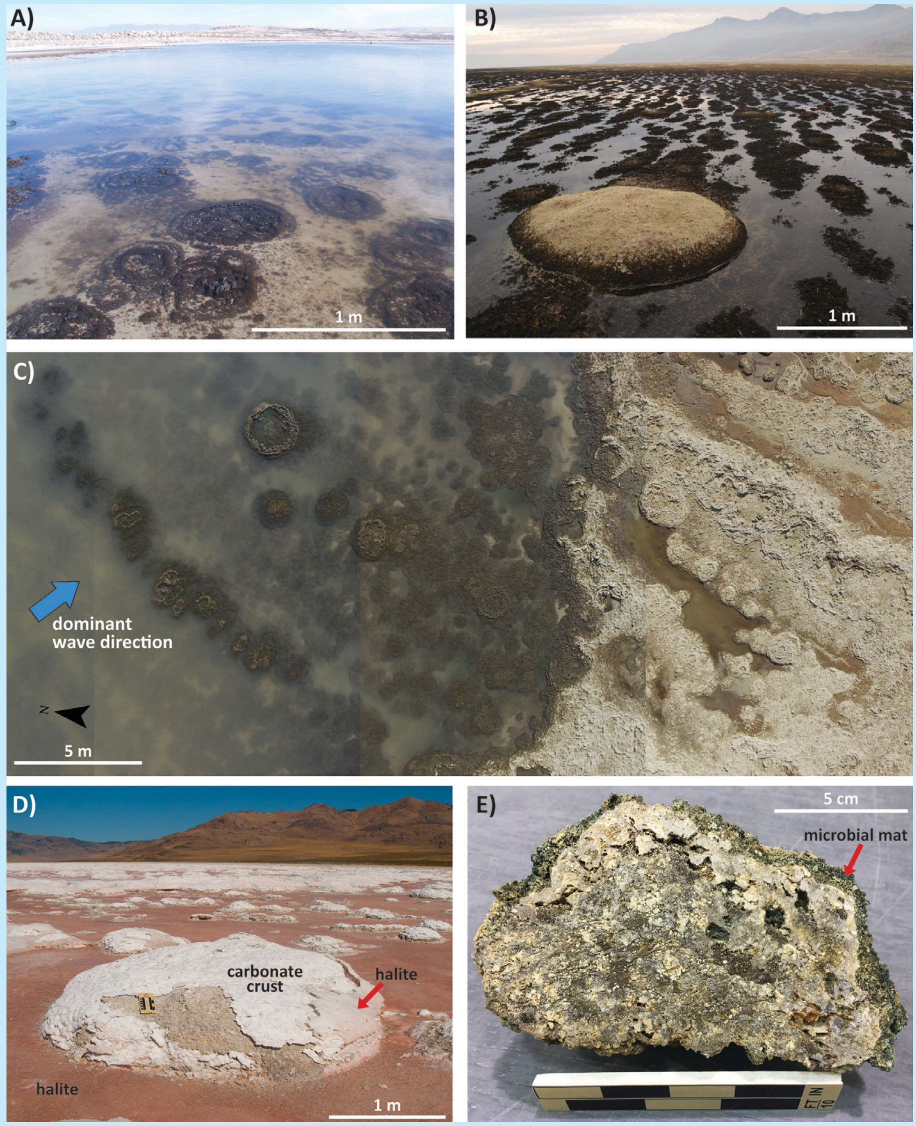

Figure 2: Images of microbialites from around GSL. A) Flat, low-relief microbialites in the low-gradient, low-energy, sheltered Bridger Bay. The dark brown color is the living microbial mat covering the surface of the microbialites. B) Large, well-cemented microbialite dome near the northeastern tip of Stansbury Island. The low lake level has caused the microbial mat on the top of the dome to die and erode, exposing the light gray carbonate below. Surrounding the single dome are low-relief, elongate (parallel to dominant wave direction) microbialites. C) UAV image of microbialites, Antelope Island. D) Microbialite dome from the north arm near Promontory Point surrounded and partially covered by halite. E) Small slabbed microbialite (from Bridger Bay) showing the mostly structureless interior.

Microbialite Rings

In nearshore areas of GSL, which have historically been under water but are exposed at low lake levels, the microbialites display a ring-shaped structure. These patterns are particularly noticeable on the northern shore of Bridger Bay, Antelope Island, and range in size from 0.5 m to 2 m in diameter. Several UAV transects show a clear offshore to nearshore transition of fully formed domes (at elevations <1277.6 m, <4191.5 ft), to collapsed domes (<1278.0 m, <4193.0 ft), to ring structures (<1278.9 m, <4196.0 ft) (Fig. 4A).

These microbialite rings are interpreted as a result of exposure and erosion of what were once more typical, fully-submerged domal structures, as opposed to primary constructs (Fig. 4A-B). First, microbialite domes of various sizes formed in several feet of water in nearshore environments and, when submerged, are covered with a microbial mat (Fig. 4B). However, in some cases (like in Bridger Bay), the domal structure is not solid and consists of a poorly lithified outer shell, 5-15 cm thick, with mostly unconsolidated clay and ooids in the interior. Next, as lake level falls and the water table drops, there is a corresponding decrease in pore pressure. The unconsolidated clay and ooids compact and the microbialite dome collapses, leaving behind a raised outer ring. With continued exposure, the microbial mat dies and erodes, leaving behind only the whitish-gray carbonate. With prolonged exposure and continued erosion, possibly aided by brief periods of inundation or storm action, the central collapsed part of the microbialite further disintegrates. Continued wave action washes out the broken material, leaving behind only the outer ring. If lake level rises again for an extended period (like from the 1960s to the early 2000s), the eroded ring structure can be recolonized by microbes and a new microbial mat can form. An alternate hypothesis is that the rings could be early primary structures where growth in the central

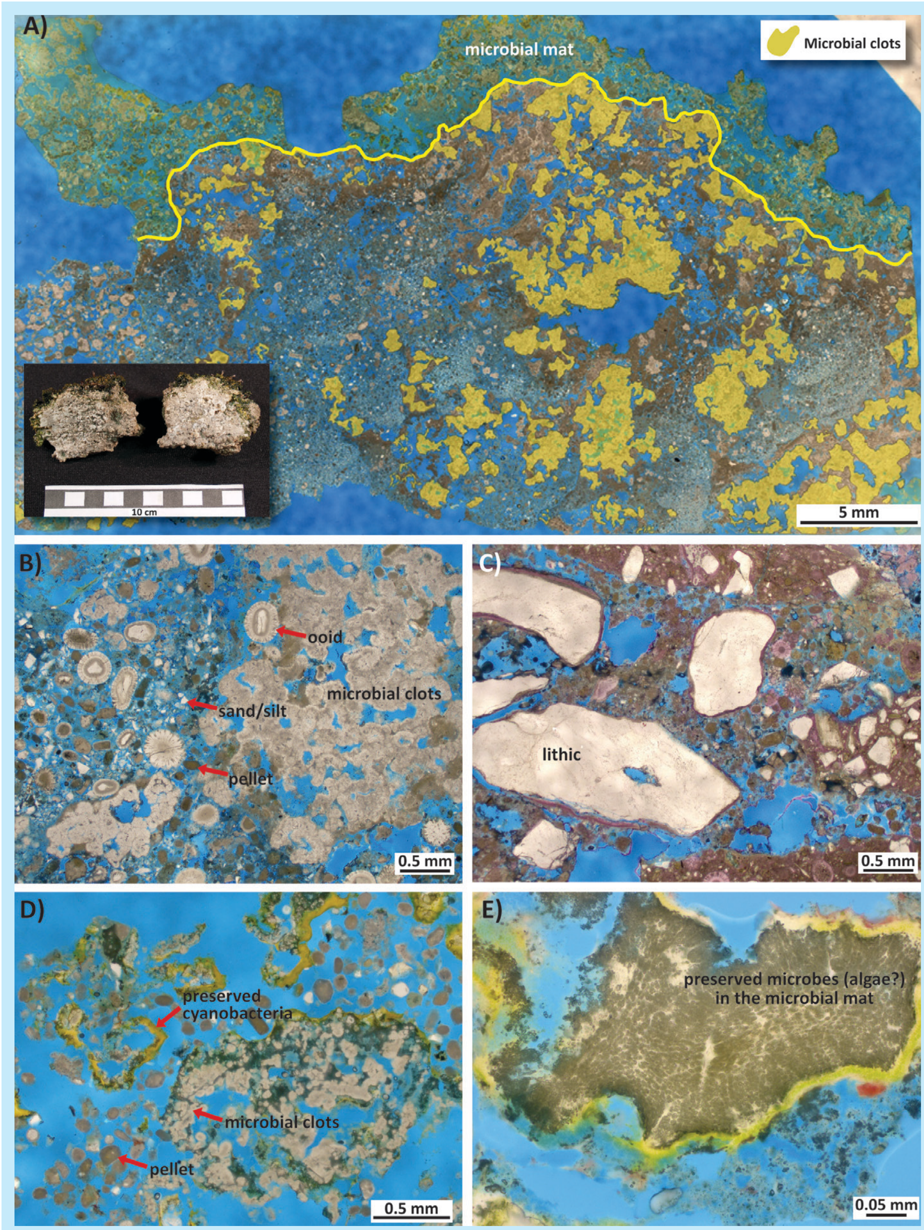

Figure 3: Photomicrographs of GSL microbialites. A) Thin section photomosaic of a microbialite from near Antelope Island (inset image of hand sample) showing detailed micro-facies mapping. B) Microbialite from Bridger Bay. C) Microbialite from near Buffalo Point. The high-energy, steep-gradient shoreline near Buffalo Point is close to bedrock, resulting in more lithic fragments being incorporated into the microbialite structures (up to 10% of total volume). D) Microbial mat (from a microbialite off the northeastern tip of Stansbury Island) showing preserved greenish microbes (possibly cyanobacteria) forming a box-work-like texture, similar to the fibrous aragonitic microbial clots in the lower-central area of the image. E) Close-up of microbial mat in image A showing microbes (algae?) that were preserved through the thin-section-making process.

portion of the microbialite is inhibited due to nearshore erosional processes.

Microbialite Ridges

In a few areas around GSL, microbial mats form small (10-15 cm wide, 5-10 cm tall), linear ridges that are continuous for several meters (Fig. 5A-C). These structures are typically parallel to shore and perpendicular to wave action. The most probable interpretation for the ridge formation is related to the lithification of wave ripples on an ooid sand bar. In specific areas, wave ripples formed in nearshore areas adjacent and slightly south of rocky points of land (e.g., southwestern tip of Buffalo Point on Antelope Island and the southern, lakeward tip of Promontory Point). At some point, isopachous aragonite cement developed (Fig. 5D), as well as exposure-related meniscus cements, which partially lithified the ooid sand preserving the ripple shape (Fig. 5E). After a rise in lake level and continued wave action, the troughs of the preserved ripples filled with unconsolidated ooid sand, but the crests of the ripples remained as slightly elevated hard substrates. With continued inundation, microbial mats formed on the crests of the preserved ripples (Fig. 5A-C). Similar to the microbialite rings, when the ridges are exposed, the microbial mat erodes off leaving behind the lithified ooid sand ridges (Fig. 5D), which could be re-colonized if lake levels rise again.

Polygonal Structures and Groundwater

Shrinkage polygons are common along the shallow shores of saline/playa lakes (Neal et al., 1968). These structures were first recognized around GSL by Currey (1980) and later referenced by Bouton et al. (2016) and Janecke and Evans (2017). In GSL, two types of polygons were identified: 1) smaller polygons that form closer to shore at slightly higher elevations, and 2) larger, mega-polygons that formed farther out on the shallow shelf at slightly lower elevations. With the increased resolution of aerial imagery (e.g., Google Earth), combined with historic low lake levels, these unique structures are easily observed and mapped around the lake (Fig. 1).

Small-scale shrinkage polygons can be observed near Rozel Point in the north arm (Fig. 6A). On average these features are 4-9 m in diameter and form on the exposed lake bed closer to the high-water line, between ~1278.3-1279.9 m (4194-4199 ft) in elevation. The surface of the lake bed is mostly composed of ooid sand and mud, underlain by clay. The polygons form when lake level retreats and exposure results in desiccation of the nearshore sediments. The cracked perimeter of the polygons is filled by upwelling clay, possibly aided by groundwater movement (Fig. 6A, inset). The clay forms raised ridges making the polygons easily identified on aerial imagery. These smaller polygons are interpreted as "recent" ephemeral features that come and go with seasonal changes in lake level and are not generally associated with microbialites.

The large-scale polygons observed on the shallow lake margins, slightly deeper than the smaller polygons, are truly remarkable, not only for their size, but also their direct association with GSL microbialites (Fig. 6B-D). On average, these mega-polygons are 30-75 m in diameter and cover ~145 km^2 of the offshore margins around GSL (Fig. 1). The perimeters of the mega-polygons became preferred locations for extensive microbialite formation (Fig. 6C-D). Using the smaller polygons as an analog, it is assumed that the perimeters were areas of slightly higher topography due to upwardly injected clay, which could have created a preferred location for microbialite growth. In addition, the upwelling around the perimeter suggests a pathway for groundwater (Fig. 6E). Calcium-rich groundwater could have increased the ability of microbes to mediate the precipitation of calcium carbonate, leading to extensive microbialite formation. In fact, these polygon-associated microbialites are more cemented/lithified, and hence less likely to collapse, compared to microbialites in other locations.

The timing of mega-polygon formation is unknown, but if the polygons formed during a period of exposure, their formation timing can be constrained based on their elevation compared to lake level records. The lowest elevation with mega-polygon structures is ~1275.6 m (4185 ft), the last time lake level is hypothesized to have receded below this level was during the mid-Holocene Climatic Optimum (~8-6 ka; Murchison, 1989; Steponaitis, 2015). As with the smaller polygons, a subsequent rise in lake level would rapidly degrade and/or destroy the polygonal structures. Thus, the excellent preservation of the mega-polygons could suggest that the rimming GSL microbialites formed rather rapidly during a large-scale lake level transgression, preserving the polygonal shape before the sediments could be reworked. This also suggests that these microbialites are relatively old (~6 ka) and not "modern" like has been suggested.

These interpretations suggest an important link between microbialites and groundwater within GSL, similar to findings in the ancient lacustrine rock record, particularly the Green River Formation (e.g., Awramik and Buchheim, 2015). The microbialites on the perimeters of the polygons are often large, well-formed, and more lithified than microbialites in areas like Bridger Bay, possibly due to the availability of calcium-rich groundwater. In some cases, pathways in the interiors of the domal microbialites are lined with a dense, finely laminated travertine-like carbonate, an indication that groundwater is flowing through these structures. Further research could clarify the possibly underappreciated role groundwater contributes to the formation of GSL microbialites.

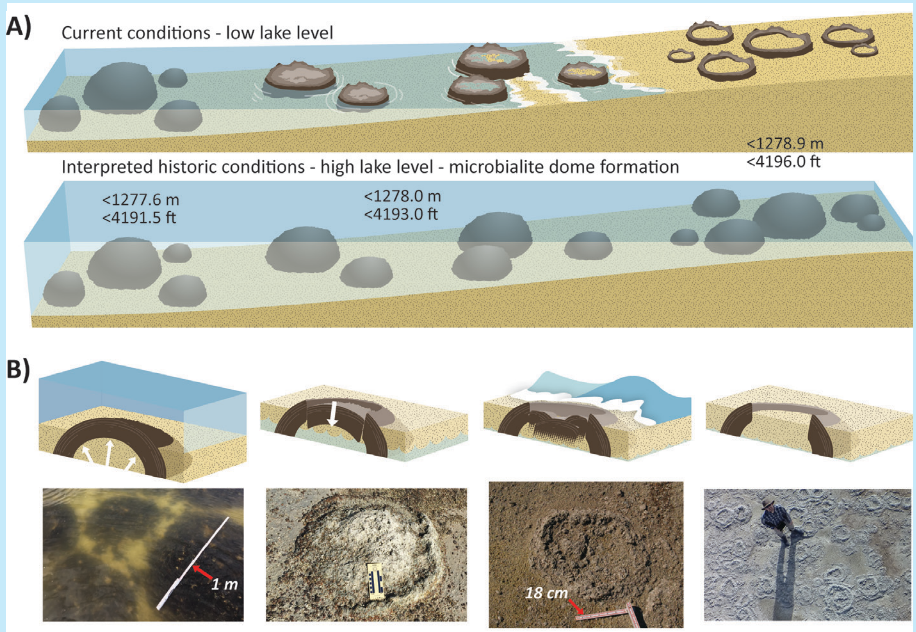

Figure 4: Microbialite ring structures that form in nearshore environments. A) Current, low lake level conditions displaying the offshore to onshore transition of domes to rings and the interpreted high lake level conditions at the time of microbialite dome formation. B) A suggested process for the formation of microbialite ring structures with photographic examples.

SUMMARY

Recent oil discoveries in South Atlantic pre-salt lacustrine reservoirs, as well as historic low lake levels of GSL, have greatly renewed and heightened interest in the lake's microbialite population. Researchers are beginning to recognize that these structures are unique compared to other global ancient and recent microbialite examples, but similarities also exist. GSL microbialites do not easily fit into the recognized microbialite naming convention, given that they are mostly structureless and are made up of dominantly loosely cemented carbonate grains and debris, display significant porosity, and contain only minor accumulations of microbial clots. The main driver of GSL microbialite morphology is mostly related to local environmental and lake conditions. Periods of exposure and erosion also play a large role in their morphology. In addition, the possible importance of groundwater on the formation of GSL microbialites and their growth location is becoming more apparent. Several questions still remain unanswered and should be the focus of future studies, including: 1) What is the precise age for

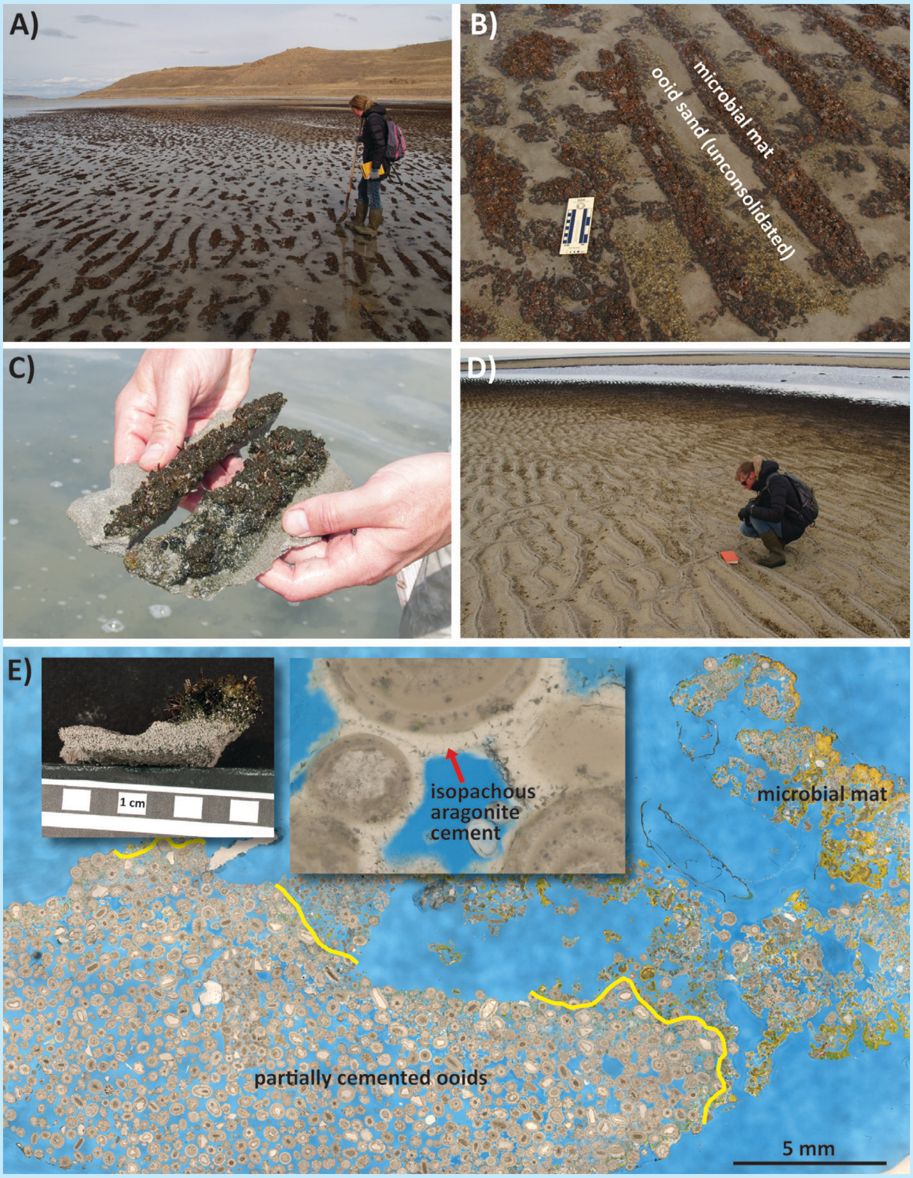

Figure 5: Microbialite ridge structures that form on the crests of cemented wave ripples. A) Ridges off the southwestern tip of Buffalo Point. The ridges are oriented north-south and are mostly perpendicular to wave direction. B) Close-up of ridges near Buffalo Point. C) Cemented ooid sand wave ripple with microbial mat covering the ripple crest. D) Ridges exposed near the southwestern tip of Promontory Point; the microbial mat has eroded, exposing the underlying cemented ooids. E) Photomicrograph of the cemented ooid sand ripple with microbial mat (inset image of hand sample). The close-up inset image shows isopachous cement around the ooids.

GSL microbialite formation? 2) Has there been more than one period of development? 3) Does the microbe community that currently inhabits the microbial mats mediate the precipitation of new calcium carbonate or are the microbes simply taking advantage of hard relict substrates? 4) Presently the lake water is depleted in calcium relative to other major ions; at other points in the lake's history, maybe during periods of high run-off (transgressions), could the same microbes that live in the lake today "build" these structures?

With lake levels projected to remain low, researchers will continue to have unprecedented access to these remarkable structures. Further research will not only provide a better understanding of lacustrine hydrocarbon reservoirs but will also provide insights into the evolution of GSL geomicrobiology and how it relates to the rest of this important ecosystem.

ACKNOWLEDGEMENTS

David Eby and Thomas Chidsey made significant contributions to this project. This research also benefited greatly from discussions and field excursions with S. Awramik, B. Baxter, E. Boyd, P. Buchheim, C. Frantz, M. Lindsey, and D. Newell. B. Pratt and J. Bishop provided extensive reviews that greatly improved this manuscript, as well as suggestions by the editor, L. Birgenheier.

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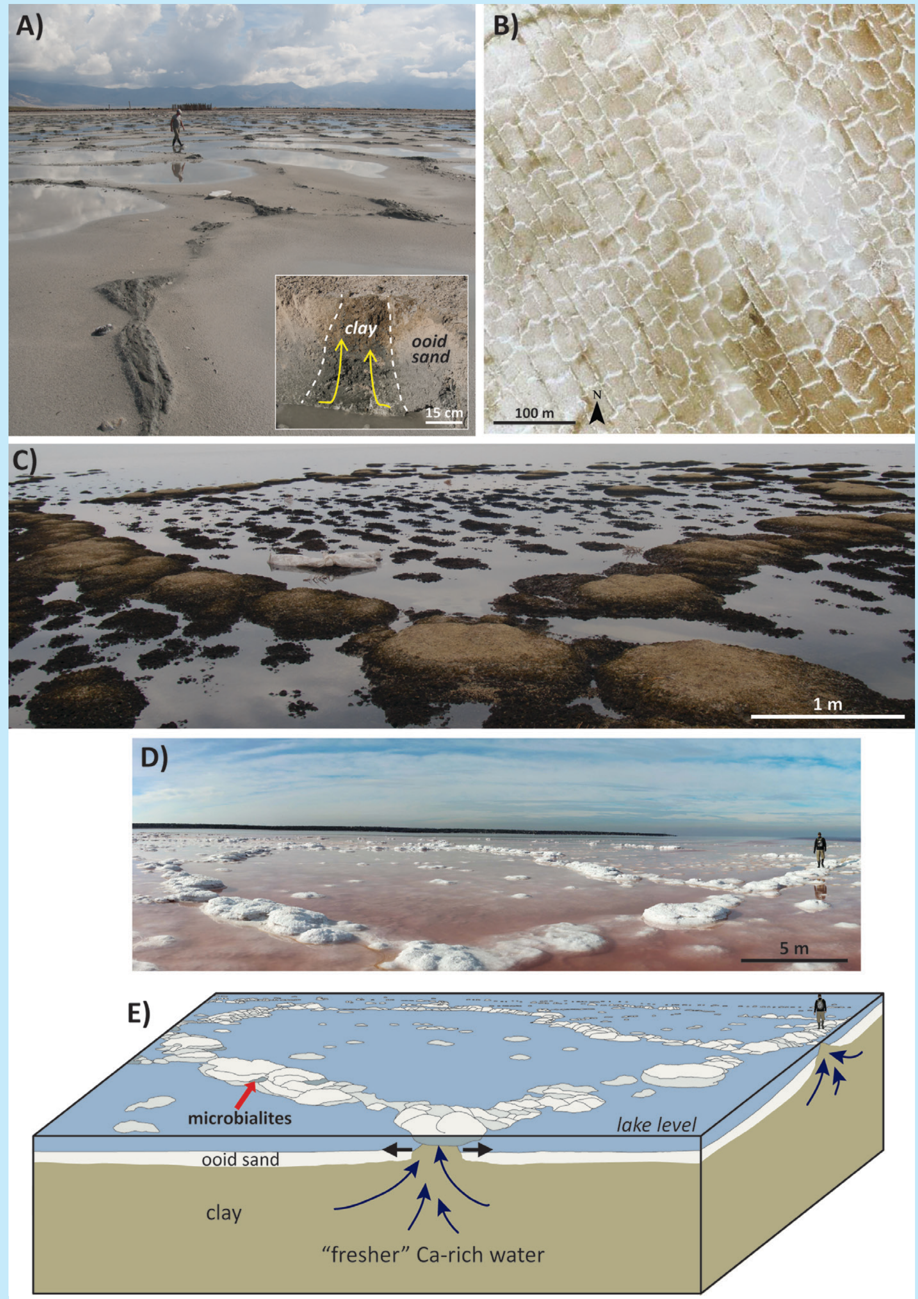

Figure 6: Images of shrinkage polygons around GSL. A) Small-scale polygons, with upwardly injected clay around the perimeters, Rozel Point (inset, trench through polygon perimeter). B) Google Earth image (August 2014) of mega-polygons near Promontory Point. C) Partially exposed microbialites along the perimeter of a mega-polygon near the northeastern tip of Stansbury Island. D) Mega-polygons and associated microbialites near Promontory Point (white/pink areas are halite crust). E) Suggested mega-polygon formation mechanism based on photograph in D.

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Accepted March 2019

PRESIDENT'S COMMENTS

"*Time present and time past/ Are both perhaps present in time future/ And time future contained in time past.*" — T.S. Eliot (*Burnt Norton*)

As an undergraduate geology major, I attended what turned out to be a classically hard-rock school and quickly fell in with metamorphic rocks. Attracted initially by the vibrant hues in thin section, I also derived a sense of accomplishment by the intellectual grasp of a phase diagram, and its way of revealing deep-Earth conditions. By comparison, studying sedimentary rocks struck me as a dreary undertaking: Some exhibited such fragility as to scarcely merit the moniker "rock," and "grunge" seemed to be the favored adjective to apply in sedimentary petrography lab (before its use as a genre of rock entirely apart from the geological). It was difficult to muster excitement about a book entitled *Sand and Sandstone*, and UCLA graduate students derided lithologies that failed to produce a reverberating ring when struck with a rock hammer. It didn't help matters when I learned that even luminaries of the discipline had infamously ridiculed allied subdisciplines, as with PD Krynine's take on stratigraphy as the "complete triumph of terminology over facts and common sense" (Folk and Ferm, 1966).

Then, late in my undergraduate days, I took an elective called "Sedimentation and Tectonics." When seemingly rote point counts of grungy sandstone thin sections through the Great Valley Sequence enabled reconstruction of the tectonic history of the western plate margin, I was hooked. The professor— Ray Ingersoll— taught us to see worlds in grains of sand. Sedimentary geology perfectly blended science, art and imagination; plus, knowing my glaucophane from my glauconite still came in handy.

But the tendrils of sedimentary geology, including paleontology, extend much broader than tectonics. Sedimentary rocks bequeathed the single greatest contribution of geology to human thought (paraphrasing Gould, 1988): the concept of Deep Time. The idea that Earth possesses a history stretching so far into "the abyss of time" (Playfair, 1805) affords glimpses into the very origin of life on the planet, its evolution, the impacts of life on the physical evolution of the planet and, in exchange, the impacts of planetary processes on life. The myriad "alternative-Earth scenarios" archived in the geologic record, including fantastical visions of climatic extremes that burst the boundaries of our imaginings— this, all this, lies within our grasps. All this, from mere mud. And forams. And limestone. And every other manner of lithologic and paleontologic grunge— aided increasingly by some strategic chemistry, physics, and/or biology.

SEPM sprang out of the strictly utilitarian yet profound need to tell time— i.e., to correlate wells, and the recognition that micropaleontology plays an essential role in this endeavor (Russell, 1970). The early days of applied sedimentary geology earned its practitioners unjust and disparaging comparisons to philatelists. But we've thankfully shed this mantle because our ability to delve into Deep Time, and document its rhythms and convulsions, enables us to peer into the very nexus of the Earth System— climate, the Critical Zone, life and, thereupon, the deepest mysteries in science. Whether you probe this history by studying the vicissitudes of life, climate, or tectonics— on the sea or on land— you do so via the lens of paleontology and sedimentary geology.

At a time when pressures on the planet's habitable systems are so great — owing to our profound proliferation as a species, sedimentary geologists and paleontologists can play essential roles. By virtue of the dual metaphors of time as arrow and cycle, of sediments as records of both history and laws, we are the archivists of Earth's past and thereby the oracles of its future.

Lynn Soreghan,
SEPM President 2019

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"Bringing the Sedimentary Geology Community Together"
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THE GEOLOGICAL SOCIETY OF AMERICA®

SEDIMENTARY GEOLOGY DIVISION

SEDIMENTARY GEOLOGY DIVISION

Spring 2019 Newsletter

Undergraduate researcher Sierra Heimel (Fort Lewis College) studying the interaction of stratigraphy, diagenesis, and fractures as controls on karst aquifers in the Redwall Limestone, Grand Canyon.

"Sedimentary my dear Watson" is of course much of the answer to many of the most fascinating questions in geology - but we could be biased. In fact, the more we study the dynamics of Earth processes, the more we understand that the interconnectedness of Earth systems requires interdisciplinary collaboration and new "big" ways to analyze data. In this light, it is inspiring to see the superb, and integrative technical sessions, field trips and short courses that our division members are creating for the upcoming GSA meeting in Phoenix, and for the 2020 International Sedimentary Geology Congress in Flagstaff AZ hosted by SEPM, (and co-sponsored by our division). Join us for these meetings and upcoming regional GSA meetings for invigorating science and a chance to be with your wonderful geologic community.

Annual Meeting Recap

2018 GSA ANNUAL MEETING IN INDIANAPOLIS INDIANA RECAP

The 40 Sedimentary Geology Division sponsored sessions at the 2018 Annual GSA Meeting in Indianapolis drew very engaged and attentive crowds. These topical sessions covered a very diverse spectrum of sedimentary-related science from around the world.

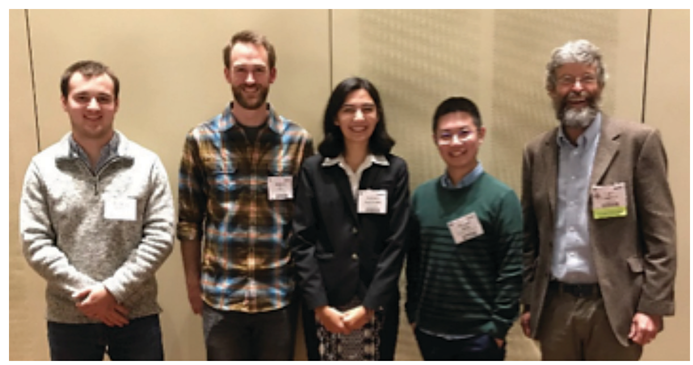
The SEPM/SGD sponsored student poster session ***"T168. Sedimentary Geology Division/SEPM Student Research Competition: Dynamics of Stratigraphy and Sedimentation (Posters)"*** Convened by Amy Weislogel, SGD Vice-Chair, featured 40 student poster presenters. The posters were judged for scientific and presentation quality and the top 4 winners were honored at the SGD Seds and Suds Awards Ceremony. (see page 2).

Seds and Suds 2018 **in Indianapolis! Thanks to SEPM for donating 10 publications for door prizes!**

Dr. Kenneth Miller (Rutgers University) was presented with the **Laurence L. Sloss Award** from SGD Chair, Dr. Gary Gianniny at the SGD Awards Ceremony "Seds and Suds".

Dr. William T. Jackson (left) was received with the **2018 Stephen E. Laubach Structural Diagenesis Research Award** which is jointly awarded by the Sedimentary Geology Division and the Structure and Tectonics Division. Presented by SGD Chair, Dr. Gary Gianniny (right).

Augustin Kriscautzky, (left) receives the **2018 SGD Student Research Award** from SGD Chair, Gary Gianniny (right).



2018 SEPM/SGD Student poster award winners from the national GSA meeting in Indianapolis. From left to right….

Joshua R. Malone, et al., Detrital zircon provenance of quartzite gastroliths in the Jurassic Morrison Formation, Wyoming, USA.

Daniel S Coutts et al., Deciphering controls on turbidite channel sedimentation patterns along an active margin: Upper Nanaimo Group, British Columbia, Canada [eh?]

Asmara Lehrmann et al., Frequency of paleo-floods in Mobile Bay from sediment grains size and elemental analyses: Implications for recent estuarine eutrophication events.

Mingyu Yang et al., Carbonate cementation related to cryogenic brine formation during Cenozoic glaciation, McMurdo Sound, Antarctica

Bylaw Revisions Approved and McLaurin elected new Secretary Treasurer of SGD, Fall 2018 ballot.

Thank you to all of you who voted on our fall 2018 ballot with suggested revisions to our bylaws and and for the Secretary Treasurer. The bylaw revisions where approved. 205 for, 1 against, 60 abstain.

We welcome Bret McLaurin as our new Secretary Treasurer, and sincerely thank Sam Hudson for being a candidate. We hope he will be back on an SGD ballot soon! Secretary Treasure election results: McLaurin 147, Hudson 105, abstain 18.

Student Representatives on the Management Board -Part of SGD's commitment-

With the changes adopted in the SGD Bylaws last Fall, SGD increased its commitment to formal student representation on our Management Board! Student Representatives will serve one year as an ex-officio member of the Management Board before cycling into the voting Student Representative for a year. Candidates must be student members of the Sedimentary Division of GSA. Nominations follow the same procedure as those for Vice Chair above.

Nominations now open for the next Vice-Chair of SGD and the Second Student Representative.

Here it is – your chance to serve your colleagues and help keep GSA the premier place for sharing your research and interacting with others who love sediments!! A nomination maybe made by the Nominations Committee of SGD or by four voting affiliates of the Division in good standing who shall verify that the candidate is qualified and willing to serve in that office. **Nominations will be accepted if signed by the nominating affiliates and received by Brett McLaurin, SGD Secretary-Treasurer no later than June 1, 2019** (bmclauri@bloomu.edu).

Candidates must be members of the Sedimentary Division of GSA, and Student Representative candidates must be student members of SGD. Officers are expected to attend the National Annual meetings of GSA. Our Bylaws require that these be published in the *Sedimentary Record*, however that will go to press after the national GSA Meeting (Sept 22-25) when officer transitions occur. Information on the candidates will be sent to the membership and sent to members via e-mail or surface mail by June 15th and we anticipate have elections with voting open July 15 – August 1, 2019. The results of these elections will be announced via GSA Division e-mail August 5th, and published in the SEPM Sedimentary Record in the Fall.

Officer Transitions: Next fall after the Phoenix GSA meeting, the current SGD Vice Chair, Amy Weislogel, will become the new Chair of the Sedimentary Geology Division, and Gary Gianniny will cycle to "Past Chair". After 6 years of service to SGD, Kate Giles will step down as Past Chair – Thank you Kate!!

Sedimentary Geology Division Awards and Grants: Upcoming deadlines:

The Sedimentary Geology Division Student Research Award March 1, 2019

This award is given to an outstanding student grant proposal in the field of sedimentary geology and stratigraphy selected by the Geological Society of America Committee on Research Grants from the applications submitted annually to the GSA Research Grants Program.
(https://community.geosociety.org/sedimentarygeologydiv/awards/new-item)

Stephen E. Laubach Structural Diagenesis Research Award April 1, 2019

This award promotes research combining structural geology and diagenesis, and curriculum development in structural diagenesis.
https://community.geosociety.org/sedimentarygeologydiv/awards/laubach

Too late… The Laurence L. Sloss Award for Sedimentary Geology due Feb 15, 2019

This award is given annually to a sedimentary geologist whose lifetime achievements best exemplify those of Larry Sloss—i.e., achievements that contribute widely to the field of sedimentary geology and service to the Geological Society of America. https://community.geosociety.org/sedimentarygeologydiv/awards/sloss

SEPM/SGD Student Poster Awards at GSA in Phoenix 2019! Make sure your student posters compete for one of the four, $500 prizes for best posters!!

Four awards are given to SGD Student Members who present posters during the SEPM/SGD student poster sessions at the annual meeting. Students need to attend the Sedimentary Geology Division business meeting and awards reception to find out if they won and to claim their award. Awards are generously sponsored by our SEPM, and SGD.

Find us on Social Media!

Find us on Facebook, Instagram and Twitter **@GSA.SGD**!

Join us this year at the annual meeting in Phoenix! As we go to press the Sedimentary Geology Division is working daily with session conveners to sponsor a potential Pardee Symposium on Earth-life coevolution in the Neoproterozoic and numerous sedimentary geology focused sessions ranging from big data, to continental margin systems, the PETM, continental and oceanic drilling programs, and many more.

2019 Sedimentary Geology Division Officers:

Chair – Gary Gianniny (gianniny_g@fortlewis.edu)
Vice Chair – Amy Weislogel (Amy.Weislogel@mail.wvu.edu)
Secretary Treasurer – Brett McLaurin
Student Representative – Shannon Cofield
Past Chair – Kate Giles

Sedimentary Geology Division Volunteers:

Representative to GSA Council – Marjorie Chan
Webmaster – Stefania Laronga
International Student Outreach Coordinator – Angela Delaloye
Ex Officio Management Board Member – Howard Harper, SEPM

Thanks to Lynn Soreghan (SEPM President) for joining us at the Management Board meeting in 2019

2019 Joint Technical Program Committee (JTPC) Representatives for SGD:

Piret Plink-Bjorklund, Colorado School of Mines
Ryan Morgan, Tarleton University

SEPM Annual Meeting Events at ACE – San Antonio

< https://ace.aapg.org/2019/networking-and-events/sepm-annual-meeting>

Field Trips < https://ace.aapg.org/2019/technical-program/field-trips>

- FT01-Slope and Deep Water Mixed Carbonate-Siliciclastic Architectural Elements of the Delaware Basin: A Core and Field Workshop
- FT02-Carboniferous Strata and Reservoir Analogs of the Sacramento Mountains, New Mexico
- FT04-Fluvial and Coastal Clastic Sedimentology and Ichnology in Modern Environments and Core
- FT06-Oceanic Anoxic Events - 1A&B in Central Texas
- FT07-Effects of the K-Pg Impact in Outcrops and Cores: Brazil River and IODP Core Repository
- FT10- Geologic Controls on Production From the Upper Cretaceous Eagle Ford and Austin Chalk Formations, South Texas
- FT12- Modern Texas Coastal Geology as Reservoir Analogs

Short Courses < https://ace.aapg.org/2019/technical-program/short-courses>

- SC01-Deepwater Depositional Environments: Processes and Products
- SC02-Advances in Representing Geologic Heterogeneity in Reservoir Models
- SC06-Sequence Stratigraphy for Graduate Students
- SC09-Deltas: Processes, Stratigraphy, and Reservoirs – Core Workshop
- SC12-Integrated Approaches in Provenance – Tools and Recent Advancements Applied to Exploration
- SC13-Essentials for Understanding Unconventional Mudrock Plays
- SC14-Advanced Geochemical Methods
- SC15-Introduction to Data Science and Machine Learning in the Geosciences

SUNDAY

- ICE Breaker – SEPM Booth – (Henry B Gonzalez Convention Center)

MONDAY

- SEPM Research Groups (Open) – (Marriott Riverwalk)

TUESDAY

- SEPM Research Symposium – A Look Into the Future of Energy and Sustainability Using the Sedimentary Record – (HB Gonzalez CC)
- SEPM Luncheon (ticketed) –(HB Gonzalez CC): *Seismic Geomorphology – From the Earth's Ocean Depths to the Distal Planets, A Revolution in Reconstructing Landscape Form and Processes* – Dr. Lesli Wood
- SEPM President's Reception and Awards Ceremony (Open) (Marriott Riverwalk) – Dr. Lynn Soreghan, President

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