Geology 5315/6332
Carbonate Geochemistry, Petrography, and Depositional Systems

Lecture: Monday & Wednesday: 12:30-1:20pm; GS 404
Lab: Monday: 1:30 - 3:20pm; GS 320
Instructors: Drs. Kate Giles and Ben Brunner
Office: Geological Science 201
E-mail: Kate- kagiles@utep.edu and Ben- bbrunner@utep.edu
Office Hours: By email appointment.

Assignments and Grading
Grades will be based on performance on the following:

<table>
<thead>
<tr>
<th>Assignment</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weekly Quiz, Group Exercise / Discussion</td>
<td>70 pts</td>
</tr>
<tr>
<td>Weekly Lab (10 labs at 10pts each)</td>
<td>100 pts</td>
</tr>
<tr>
<td>Practical Lab Exam CO₂ Grain Types (Week of Oct 20)</td>
<td>50 pts</td>
</tr>
<tr>
<td>Field Trip 1 Exercise: Shelf margin facies, Sacramento Mountains (Nov. 7)</td>
<td>30 pts</td>
</tr>
<tr>
<td>Field Trip 2 Exercise: Permian Reef Complex (Nov. 14 &amp;15)</td>
<td>50 pts</td>
</tr>
<tr>
<td><strong>Total:</strong></td>
<td><strong>300 pts</strong></td>
</tr>
</tbody>
</table>

Readings
There is no required textbook for this course. However, I strongly suggest purchasing Scholle, P. A. and Ulmer-Scholle, D. S, 2003, A Color Guide to the Petrography of Carbonate Rocks: AAPG Memoir 77, 474 p. Referenced readings for Lecture are found in a purple folder on Blackboard marked “Carbonate Readings”. Please do the reading assignment prior to class for best success.

Weekly Quiz/Group Assignments/Discussion
Quizzes and assignments will be made available to you either via Blackboard or direct email. We will set deadlines after consulting with you, so that everybody can submit their assignment on time. Late submissions will not be accepted (i.e. 0 points). The group assignment will be graded for the entire group, unless group members raise concerns about the performance of the peers. Grading of your contribution and activity in discussions will be done by both instructors, and averaged. The recipe to obtain a good grade in such discussion is to be prepared.

Weekly Lab Assignments
To be worked on in GS 320 during scheduled Lab time. After hours can use either yourscope in GS 320 when the room is open or in GS 201. microscope time slot and turned in via email the following Thursday before the end of lab time. Kate will leave a box with thin sections and hand samples on the table next to the microscope in 201 for each weeks lab. Email Kate with any questions about the lab.

Practical Lab Exam
A suite of 20 thin sections will be housed in GS 201. You will schedule a 3 hour time slot to come into 201 and use the microscope to take the exam. We will email you the exam (Word document) in the morning of the day prior to your exam timeslot. You will fill in the answers on the word document and email completed exam to Kate. The exam will be focused on determination of common carbonate grain types in thin section.

Fieldtrip Exercises
This will be a handout with questions and observations made at a series of stops on the fieldtrip. To be completed and turned in at the end of each fieldtrip.
**Required Field Trips**

Two field trips are required for this course. The field trips will be graded based on participation in discussions and quality of your field notes/exercises. Field notes and exercises will be handed in at the end of each field trip.

**Fieldtrip 1: Saturday & Sunday Nov. 12 & 13 (Overnight) Required**
Permit Reef Complex, Guadalupe Mountains, and Carlsbad Caverns. Depart Geological Sciences at 8:00am and return by 5:00pm each day.]

**Field Trip 2: Saturday Nov. 19 Topic: TBD Required**
Shelf margin facies Sacramento Mountains or similar. Depart Geological Sciences at 8:00am and return by 5:00pm.
Fall 2022 Tentative Class Schedule  
**Geol. 5315/6332**  
Carbonate Geochemistry, Petrography, and Depositional Systems  
Lecture: M & W 12:30 - 1:20pm GS 404  
Lab: M 1:30 - 3:20pm GS 320

---

**August 22 Monday**  
**Lec 1: Brunner & Giles** Introduction of participants. Overview of class organization & introduction to topics for TBD lectures & updates on Giles, Brunner et al. paper “The salty heritage of Neoproterozoic dolostones” writing process & Grades. Intro. to CO₃ sedimentation. Carbonates are born, not made! Carbonate classification. Carbonate marine depositional profile/environments.  
**Lecture Reading 01:**  
**Lab 0:** Assign microscopes. Review basics of microscope.  
*Basic chemistry I: Elementary, my dear Watson!*  
Atoms, isotopes, elements, oxidation state  
**Lab Reference Reading:** Periodic table (made available on blackboard)

---

**August 24 Wednesday**  
**Lec. 2: Giles** Carbonate mineralogy  
**Lecture Reading 02:**  

---

**August 29 Monday  Giles out**  
**Lec. 3 Brunner** Basic chemistry II: Opposites attract  
Ionic and covalent bonds, salts *sensu lato,* cations and anions, charge, aqueous solutions, oxyanions  
**Quiz 1 (individual)**

**Lab 1:** Determination of carbonate and commonly associated minerals in thin section and hand sample.  
**Lab Reference Reading:**  
https://doi.org/10.1306/74D714F6-2B21-11D7-8648000102C1865D

---

**August 31 Wednesday**  
**Lec. 4 Giles:** Tidal flat carbonate rocks - Non-skeletal grains (oids and pisoids; peloids and intraclasts
Lecture Reading 05:


September 5 Monday – No Class Labor Day

September 7 Wednesday – No Class Labor Day

Lec. 5: Giles Tidal flat carbonate rocks - Skeletal grains (cyanobacteria, oncolites and stromatolites; ostracods.

Lecture Reading 03:


September 12 Monday  Giles gone

Lec. 6 Brunner Basic chemistry III: Into the mud
Redox reactions (photosynthesis, respiration), redox tower in sediments, balancing of chemical equations.

Lecture Reading 04:

Quiz 2 (teamwork is allowed)

Lab 2: Non-skeletal grains (ooids, pisoids, peloids, & intraclasts)

Lab Reference Reading:


Skeletal grains – cyanobacteria, oncolites and stromatolites; ostracods.

Lab Reference Reading:

**September 14 Wednesday**

**Lec. 7 Giles** Shallow shelf, normal marine carbonate rocks - Skeletal grains I (invertebrates-molluscs, brachiopods, echinoderms, trilobites)

---

**September 19 Monday**

**Lec. 8**: Shallow shelf, normal marine carbonate rocks - Skeletal grains II (invertebrates-coral & sponges, bryozoans, forams, worm tubes, misc.)

**Lab 3**: Normal marine skeletal grains (invertebrates-molluscs, brachiopods, echinoderms, trilobites, corals, sponges, stromatoporoids, bryozoans, forams, worm tubes, misc.)

**Lab Reference Reading**:

**September 21 Wednesday**

**Lec. 9 Brunner** Basic chemistry IV: Thermodynamics and Kinetics – two sides of a coin
Knowing where the journey is supposed to go does not mean getting on the road, catalysts (life), what the hell is activity, why does complexation equal distraction, and how is it possible that the pH could sneak in so casually?

**Quiz 3 (teamwork is allowed)**

---

**September 26 Monday**

**Lec. 10 Giles**: Constituents of carbonate rocks - Carbonate mud (matrix) and the origin(s) of mud and identification of cement versus replacement spar

**Lecture Reading 06**:
https://doi.org/10.1029/2018GL081620

**Lab 4**: Matrix mud versus neomorphic and replacement spar.

**Lab Reference Reading**

September 28 Wednesday
Lec. 11 Brunner Carbonate chemistry I: The carbonic acid system
Why is this so damn complicated? Or are they just messing with us? Since when is ACD & CCD not a rock band?
Lecture Reading 07:

Quiz 4 (teamwork is allowed)

October 3 Monday
Lec. 12 Giles: Porosity types & their generation. Cement types and precipitation setting.

Lab 5: Classification of CO₃ rock porosity and cements
Lab Reference Reading

October 5 Wednesday Giles gone
Lec. 13 Brunner Carbonate chemistry II: The silicic acid system
The hidden beauty of geochemistry
Quiz 5 (teamwork is allowed)

October 10 Monday Giles gone
Lec. 14 Brunner Carbonate Diagenesis
Lecture Reading 08:

Lab 6 Diagenesis & paragenetic sequences
Lab Reference Reading

October 12 Wednesday Giles gone
Lec. 15 Brunner Carbonate chemistry III: Redox and fatal attraction – wild love affairs in carbonate rocks
The fate of Ca$^{2+}$, Mg$^{2+}$, Fe$^{2+}$/Fe$^{3+}$, Mn$^{2+}$/Mn$^{3+}$, CO$_3^{2-}$, SO$_4^{2-}$, and H$_2$S recorded in thin section

**Lecture Reading 10:**
https://doi.org/10.1306/74D714F6-2B21-11D7-8648000102C1865D

**Quiz 7/Discussion:** Geochemical meaning of content, morphology, and colors of fossils and minerals in rocks, thin sections, and stained thin sections (active participation mandated)

---

**October 17 Monday**  Giles gone
**Lec. 16 Brunner:** Dolomite and dolomitization models.

**Lecture Reading 09:**

**Quiz 6/Discussion:** the dolomite problem – a thermodynamic or kinetic issue? (active participation mandated)

**Lab 7 Dolomite**
**Lab Reference Reading:**

---

**October 19 Wednesday**
**Lec. 17 Giles:** Bank margin and shelf margin reef environment.

**Lecture Reading 12:**

---

**October 24 Monday**  This week Lab Practical Exam Carbonate Grain Types: Sign up for microscope & sample time slot

**Lec. 18 Giles:** Slope, basin margin or toe-of slope, basinal environment in the Permian Delaware Basin.

**Reading 24:**

**Lab 8** Tidal flat to basinal facies of the Permian reef complex Guadalupe Mountains, west Texas

**October 26 Wednesday**  
**Lec. 19 Giles:** Controls on platform slopes.

**October 31 Monday**  
**Lec. 20 Giles:** Sequence stratigraphy of carbonate platforms & the Permian Reef Complex.  
**Lecture Reading 25:**  

**Lab 9** Sequence Stratigraphy of the Guadalupe Mountains Permian Reef complex

**November 2 Wednesday**  
**Lec. 21 Giles:** Carbonate karst systems

**Nov. 5 & 6 Saturday & Sunday**  
**Field trip 1:** Permian Reef Complex, Guadalupe Mtns/ Carlsbad Caverns. Examine depositional facies of Permian Reef complex. Study diagenetic alteration of reef system at Carlsbad Caverns.

**November 7 Monday**  
**Lec. 22** : Class debate - do carbonate platforms really drown?  
**Lecture reading**  

**Lab 10** Cool water carbonates. Heterozoan versus Photozoan biofacies associations  
**Lab Reference Reading:**  

**November 14 Monday**  
**Lec. 23** Lacustrine Carbonates, Brazilian and Angolan Pre-salt Alkaline Lacustrine Systems
Lecture Reading:

Lab Cretaceous lacustrine carbonates Indios Mountains, West Texas

November 16 Wednesday Ben out NMSU giving talk “The many flavors of carbonates associated with salt diapirs”
Lec. TBD

November 19 Saturday
Fieldtrip 2: TBD El Paso Area
Depart Geology Department parking lot at 8:00am and return by 5:00pm.

November 21 Monday
Lec. 29 : TBD

November 23 Wednesday No Class Thanksgiving Break

November 28 Monday
Lec. 30 : TBD

November 30 Wednesday
Lec. 31 : TBD