



The experience of a lifetime

LSU students spent five weeks in Paris and Southern France taking two geology classes

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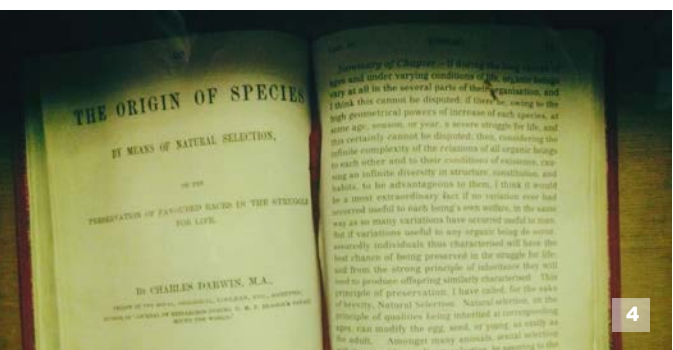
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Last August, I was contacted by Dr. Harald Leder, Director of the LSU Academic Programs Abroad (APA) and Dr. Kevin Bongiorno, a faculty in the Department of French Studies at LSU. They were organizing the Summer 2015 edition of “LSU in Paris” and were looking for one more faculty member to join the experience. They already had two French instructors (Dr. Bongiorno and John Patin), and two English instructors (Dr. Jerry Kennedy, who hold the prestigious title of Boyd Professor; and Dr. Sarah Liggett, the Donald & Norma Nash McClure Alumni Professor in the Department of English, and the director of the Communication across the Curriculum program). Having the chance to teach in the country where I spend much of my childhood was a great opportunity, and I gladly accepted the offer.

With LSU APA, each faculty member is responsible for teaching two classes, so I was left with the challenge of creating two classes that would take advantage of all that France has to offer. The new syllabi had to be submitted and approved early in the fall 2014 semester. Having done my doctoral research on the Messinian Salinity Crisis under the direction of Dr. Jean-Pierre Suc in Montpellier, I knew I had to incorporate the many fantastic outcrops that can be found in the French Riviera and in Provence. So, very naturally, two classes came to mind; a version of Historical Geology that would use the countless buildings (such as the *Musée d’Orsay*¹), monuments and science museums of Paris as lecture support, and a field geology class in Southern France. The syllabi were approved, and the “LSU in Paris” program had 45 students registered by the spring. We were at full capacity, with 16 of these students taking one or two of the geology classes offered, four of these students coming from the LSU Honors College, and most studying either geology or petroleum engineering.

We arrived at our dorm, the FIAP Jean Monnet (located in the very safe and pleasant 14th *arrondissement*) at the end of May. This dorm/hostel has a full service cafeteria, a café, some conference rooms, many classrooms perfect for our teaching needs, and it was conveniently located a five-minute walk from the *Glacière métro* station. As part of the package, all students received a subway card for the duration of their time in Paris to give them some flexibility.



Historical Geology was taught for the first three weeks of the program. In addition to daily morning lectures, we took some afternoon field trips. The first week, we went to the *Galerie d'Anatomie Comparée*^{2,3} in the magnificent *Jardin des Plantes*. This garden hosts many science museums and laboratories, and it was very humbling to see items such as one of the first edition of Darwin's book⁴ on *The Origin of Species* or walk in a building once occupied by Cuvier⁵ (also, see inset below the title). It was truly inspiring to be in the very location where this French naturalist, one of the fathers of paleontology, worked on modern and fossil comparative anatomy, the *Basin de Paris* sediments, and discovered so many extinct species.



Cuvier is not the only historically famous scientist who worked in the *Jardin des Plantes*, this garden also hosted some physicists in their Museum of Applied Physics. One of the most notable physicists was Henri Becquerel, and it is in this location, on March 1, 1896, that he discovered radioactivity⁶. You can't help, when visiting these laboratories, but to be inspired and to want to give the best of yourself, in your research and teaching endeavors.



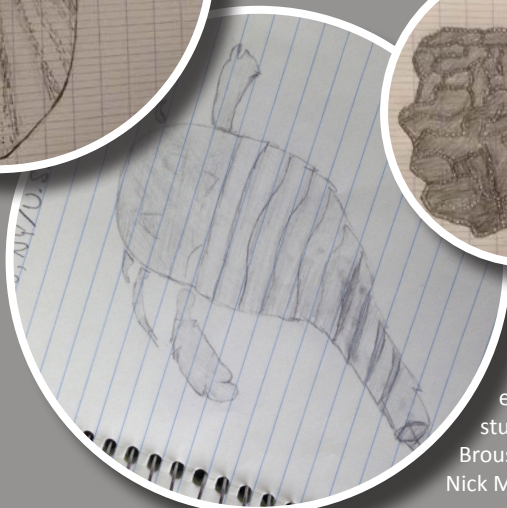
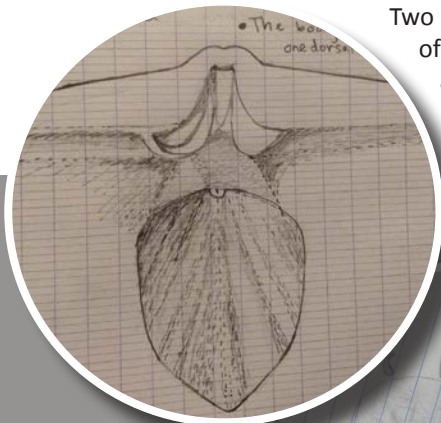
On another afternoon, our Historical Geology class was joined by Dr. Kennedy's English class and this gave us the chance to exchange our different knowledge. Dr. Kennedy took us to the house⁷ that was once inhabited by American writer Ernest Hemingway, where we learned that it was in this apartment, under the mentorship of Gertrude Stein, that Hemingway wrote *The Sun also Rises*. From there, our group walked by the *Arènes de Lutèce*, built in the year 200 with Eocene Beauchamp sandstone. The geology students shared with the English students a few of the concepts they had just learned in Historical Geology by showing some of the features seen in the sandstone, such as cross-bedded facies. We ended the day at the *Musée de la Minéralogie*^{8,9}, where the students were able to test the knowledge they had just gained that morning in the introductory chapter on mineralogy.



The second and third weeks, we spent each morning studying one of the geological time periods, starting with the Precambrian and ending with the Holocene. When I taught that class at LSU, it was generally in an auditorium with about 150 students. In Paris, this class was qualified as an Honors class, and the advantage was that I had, at most, 16 students in the class, and we had the luxury of having fabulous museums just a short subway ride from our classroom. We took advantage of this by visiting, twice, the *Musée de la Paleontologie*. Tucked in a corner of the *Jardin des Plantes*, by the Seine River, this building is less imposing than the prestigious and fabulously remodeled *Grande Galerie de l'Evolution*, but the collection on display in this museum are priceless and by far better than those visitors can see in the *Grande Galerie de l'Evolution*. This museum had on display most of the key fossils that are discussed in the textbook we were using as support for the Historical Geology class. What a treat to see these as opposed to just abstractly read about them in a book!

To help the students pay attention to details and take the time to reflect on these priceless specimens, they were all tasked to sit in this museum and draw 10 fossils of their choice (see inserts for examples of students' work), while discussing the paleo-environments that existed at the time these fossils lived. One of the LSU students' favorite was of course a fossil of a Cenomanian crawfish¹⁰. After all, we are from Louisiana and crawfish season is always on our mind. One of the impressive larger-scale fossils was the full skeleton of a specimen of *Cynhiacetes peruvianus*¹¹. It was interesting to us because one of my fellow curators at LSU, Dr. Judith Schiebout, has a *Basilosaurus* in her collection. The *Basilosaurus* whale, found in North Louisiana, is a reminder that our coastline used to be around Shreveport in the Eocene. Both genera are part of the basilosaurid Upper Eocene early whales. It was a chance to see this different genus and analyze some of their differences. A favorite of mine were the Ediacaran fossils¹². For those of you not familiar with these fossils, they were named after the Ediacara Hills of Australia where they were first discovered. Although seemingly uninteresting if you simply look at their morphology, they are truly unique because of their age. They are from the Proterozoic Eon and are found at the end of the Precambrian time, they are thus the first fossils of multicellular animals known and possibly the ancestors of anemone, annelid, and creatures such as jellyfish. The museum also had a variety of marine fossils such as sea urchins¹³ and a great section on the evolution of fishes, amphibians and reptiles.

Two other specimens I enjoyed were the replica of a *Dutuitosaurus ouazzoui*¹⁴, an extinct amphibian; and the fossil of an Eurypterid¹⁵, an extinct arthropod from the Paleozoic.



Sketches by petroleum engineering students Beth Broussard and Nick Mouille



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While living in Paris, the students had two meals a day at the FIAP, but the program also proposed weekly pizza night. Every Tuesday, the students from English, French and geology programs would gather together along the Seine River¹⁶ and enjoyed the pizza purchased by Dr. Bongiorno. The weather was fantastic (we were lucky) and musicians and tango dancers gave the riverside a touch of extra magic. Most of all, it gave us all a chance to interact between our different specialties. For instance, I learned that the beach near my grandparents' home in Antibes (at the *Plage de la Garoupe*) is where F. Scott Fitzgerald wrote his famous novel *Tender is the Night*. The French and English students learned to look at the stone on which they were sitting and realized that they were full of fossils. One of the Honors students, Joe St Cyr, an English major, wrote:

"Paris is a great place for the historical geology class because of the insane variety of rocks easily found here. We were not even on the walking tour, we had accompanied a group of girls to go shopping, and Ross [Ross Teichman, an Honors student from petroleum engineering] made the entire group stop to look at the stones on a bridge that exhibited a lot of cross-bedding structure similar to the ones we saw in the Roman arena."



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When I read his comments, it really made my day because I love the fact that these students have learned some skills that they will keep well beyond the classroom setting.



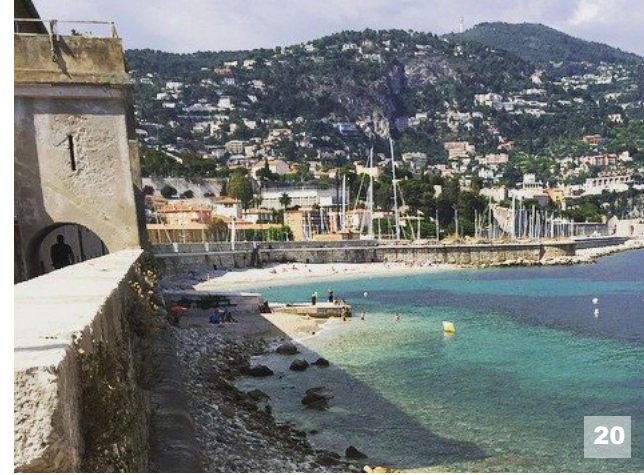
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In addition of taking full advantage of the museums, we took some walks in the street of Paris, mostly in the 5^{ème} and 11^{ème} *arrondissements*, to look at the rocks that were used in the construction of the French monuments, buildings, churches and castles. The students learned that many of the buildings in Paris are made out of rocks that came from the *Basin de Paris*, a geological sedimentary basin where successive marine layers were deposited during the Triassic to the Pliocene. For instance, the *Grande Galerie de l'Evolution*¹⁷ is made of Eocene limestone called "*Calcaire Lutetien*" and "*Calcaire de Château-Landon*." The students also learned that cobblestone streets¹⁸ can tell you a lot about the periods in which the streets were built (many of the pavements are made of sandstone named "*Gres de Fontainebleau*"). They also learned that most of the sidewalks¹⁹ in Paris are made of granite. One of these granites, the *Granite de Vire*, is Precambrian in age. Dominic Mouille, a petroleum engineer student, wrote in his essay that one of the things that amazed him about Paris is not so much the age of the buildings, but that it took *millions* of years for nature to form the rocks used in some of the construction.

The fourth week in France, the 12 students enrolled in the advance field class (Geol 4002) left Paris Saturday morning onboard the high-speed train (TGV) for the six-hour ride to Nice. Upon our arrival in Nice, a small bus (courtesy of Dr. Wicks) was waiting to drive us to the Oceanological Observatory of Villefranche-sur-Mer²⁰ (OOV), where we had an agreement allowing our students to use their dormitory, and to share the space with French graduate students conducting marine research. This historic building is located less than 10 km (4.2 miles) from Nice on the French Mediterranean coast. It is the most exhaustive marine science campus in France, and it is attached to the *Université Pierre et Marie Curie*, one of the top scientific research universities in France, and is also part of *La Sorbonne* system in Paris. The UPMC is ranked 6th in Europe in the Shanghai academic ranking and 39th worldwide.

Because the OOV is located in the beautiful small maritime town of Villefranche-sur-Mer²⁰, the students had the opportunity to walk to the beach and outdoor coffee shops and restaurants after class. It is also located just a few minutes from major cities such as Menton and Monte Carlo, so the students decided to dress up and spend their free Saturday evening at the famous Monte Carlo casino. The next day, the group took the coastal train and met in a small restaurant in Cannes to sample the Mediterranean cuisine²¹ and enjoy one day at the beach.

After this short break, the field class started with a day spent looking at the Nice inland area, focusing on Neogene and Quaternary sedimentary outcrops and discussing tectonic concepts. This was the first contact with the Southern Alps and topics such as overthrusting and uplift. We also discussed several concepts relating to Miocene and Pliocene sedimentary basins deposited in the region (datations, continental to marine sedimentation, Gilbert-type fan delta). We ended the day discussing the impact of the Messinian Salinity Crisis, i.e., the brief desiccation phase of the Mediterranean Sea and visited sites where fluvial erosion, relationships with offshore evaporite deposition, and marine reflooding were observed and discussed. For instance, the village of Carros²² provided some excellent outcrops where a Messinian erosional surface separates Burdigalian clays from what is called the Carros breccia. The fieldwork also allowed us to enjoy the beautiful scenery that surrounds you in the French Riviera as the group shared a picnic lunch in the charming mountain-top Carros village²³.



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On the second fieldwork day, we travelled to the foreland basin of external Alps and spent the day looking at Mesozoic and Cenozoic sections. More precisely, we travelled to the absolutely breath-taking region of the *Gorges du Verdon* where the students enjoyed a picnic and, for the boys, a swim in the chilly turquoise-colored water²⁴ of the Verdon river. One of the concepts discussed is the difference between valley, canyon and gorges²⁵. We also analyzed the landscape and discussed the Paleogene marine to continental evolution of this basin and of the impressive Verdon Gorges in relation with the Alps tectonics, stopping just long enough to represent LSU at the *Point Sublime*²⁶. The complicated landscape tested the observation skills of the students!

While in the *Gorges du Verdon*, we also travelled to a fantastic Mesozoic section that includes the proposed Barremian Stage Global Stratotype Section and Point (GSSP) in Angles. This thick Cretaceous sequence gave us the opportunity to discuss ways various geological fields provide different types of datation (absolute or relative), and the ammonites the students observed helped them grasp the concept of biostratigraphy first hand. The cyclic deposition and alternating layers of carbonates and marls also provided a perfect setting to discuss Milankovitch cycles²⁷. In the inset below is a picture of the proposed "golden spike" at "*banc 72*," i.e., layer 72. The Aptian, also visible at that site, is mostly composed of clays.



On the third fieldwork day, we travelled to the Var region, around the towns of Saint Maxime and Saint Tropez to study the Maures and Estérel massifs and focus on crystalline rocks. These provided a unique chance to look at magmatism, metamorphism, volcanism, and even sedimentary deposits made of volcanic clasts. This introduction to magmatic, metamorphic and volcanic rocks allowed the students to not only improve their geological knowledge of non-sedimentary rocks, but also to visit some of the most wonderful coastal landscapes on Earth.

In the Var, we started the day by visiting five sections, each displaying various levels of metamorphic grades. We discussed the origin of these deposits within the frame of the geological evolution of the region. The first deformation of the Maures Massif corresponds to thrusting by nappes involving an obducted oceanic crust sequence around 350 Ma. Fold amplification was due to magmatic intrusions dated at 303 Ma (Rolland et al., 2009, discussed in the next page). The students visited various outcrops made of crystalline rocks such as micaschists, orthogneisses, amphibolites, phyllades²⁸, and after a quick picnic^{29,30} with some Louisiana flair²⁹ in the midst of a rosé vineyard, we visited a quarry that gave us the opportunity to observe several additional types of rocks. The students saw the complicated relationships between intrusions of granite, dolerite, or basalt, and a basement made of migmatitic gneiss³¹. The session in the quarry ended after the students found a layer of pumice stones that they sampled to bring home as a present for their moms or sisters for a “spa” day.



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It was hard to leave the beautiful scenery of countless grapevines growing on fields made of siliceous-rich soils, a composition that is not surprising as these fields are next to miles of micaschist outcrops, thus providing the right substratum for these vines to produce the fabulous *Rosé de Provence* wine³².

But, the day was not over; after the morning spent in the *Massif des Maures*, we drove to the coast to see additional outcrops of volcanic rocks and clasts. We observed red conglomerates and sandstone^{33,34} made of debris of volcanic clasts such as rhyolites. I noticed later that day that most of the landscaping in the French Riviera uses these rhyolite clasts around the flowerbeds. We then travelled to the section where these clasts originated from, to view the gorgeous red Permian rhyolitic³⁵ deposits that make the *Massif de l'Esterel* so famous with its vivid red and orange colors against the turquoise Mediterranean waters. We ended the day in Saint Tropez^{36,37}, a mythical town, rich in history, and made famous by various movies. The students enjoyed a much-deserved break at the beach after a long day in the blazing sun.

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The last field day was spent a couple of hours away, west of Nice, and took us from the perialpine sea to the Rhône Delta. The purpose of the day was to visit a modern delta and discuss Early to Middle Miocene global versus Mediterranean Sea sea-level changes (sedimentology, fossil records, transgressions, regressions, onset of the Rhône River). We reviewed the impact of fluvial erosion, relationships with offshore evaporite deposition, marine reflooding, and we analyzed the outline of the Holocene Rhône Delta.

The first stop was in the village of Carry le Rouet where Dr. Philip Bart discussed the outcrop within a sequence stratigraphic context. Dr. Bart was also extremely helpful in Paris where he gave some of the lectures while I was fighting a walking pneumonia. This outcrop at Carry le Rouet beautifully displays the passage from brackish to marine conditions and provides the perfect settings to study regressive/transgressive concepts^{38,39}. The section is also very rich in various gastropods, bryozoans and coral colonies of Aquitanian ages. The inset shows some fossils of *Turitella* found by the students.

The next stop took us to an outcrop displaying a Burdigalian-age marine transgression. The erosional surface is marked by borrows made by saxicavous molluscs⁴⁰, on this wave-cut erosional surface⁴¹. This outcrop was remarkable.

One of the other outcrops visited was a Burdigalian sequence made of white calcarenite with a thick bed of abundant oyster fossils⁴² found in life position. According to my co-guide, Dr. Suc, this section marks the upper Burdigalian transgressive system track. The day ended with a couple more stops followed by the visit of the Arles Roman ruins and a visit to some of the sites (café, park, etc.) painted by van Gogh in his last days.

I am extremely grateful to my former Ph.D. advisor, Dr. Jean-Pierre Suc, who joined us and helped guide our group for these four days. Thanks to his knowledge of the region, we were able to put together a very full program and visit some of the best outcrops that the French Riviera and Provence have to offer. I couldn't have selected these spots without his guidance.



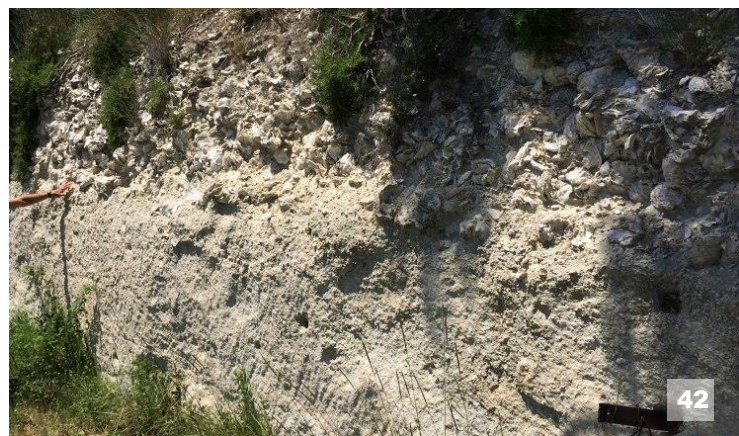
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We returned to Paris after this amazing experience in Southern France. The fifth and last week was mainly filled with exams, final presentations, and other homework. As we did not want the program to end with schoolwork only, Dr. Bongiorno organized a gourmet dinner cruise on the Seine River (see various inserts on this page). By then, all students had created bonds that will likely last a lifetime and all had a fabulous time during the dinner cruise. They had survived life with no cellular phone, very limited and slow wifi, crowded public transportation, two French strikes, and no AC... but I am fairly certain all of them had a blast. I certainly enjoyed the adventure and the chance to teach in these fantastic conditions and share some of my home country's geological sites with the students.

I want to thank Dr. Carol Wicks, Chair of the Department of Geology & Geophysics, for supporting this program and providing funding for the bus in Southern France, and Dr. Cynthia Peterson, the Dean of the College of Science, for allowing me to take on this adventure and trusting me with our students overseas. Thanks are extended to the Department of Petroleum Engineering and the Honors College for promoting this program among their students. Dr. Kevin Bongiorno (Director of *LSU in Paris*) and the APA staff members, especially Dr. Harald Leder and Jill Clemmons, are to be commended for running a very smooth operation, making life much easier on faculty and students. We are grateful to Dr. Rodolphe Lemée and the staff of the OOV in Villefranche-sur-Mer, especially, Mrs. Véronique Gourbaud-Stevens for their hospitality and efficiency! I also thank my fellow curators at the Museum of Natural Science at LSU for inspiring me to be a better naturalist every day. Lastly, thank you to Dr. Phil Bart and Dr. Jean-Pierre Suc for all their help during these five weeks. Their various input helped made this program a success, according to the students' feedback we received.

