SEG/AAPG Student Chapter
Annual Report

Field Trip XXXXXXXXX

UNIVERSITY OF MONTPELLIER

Annual report of 2015-2016 projects

XXX

Contents

INTRODUCTION

The Student Chapter of Montpellier along with first year master students in Exploration and Reservoirs Geology at the University of Montpellier has had once again a year rich in projects. The Intergenerational patronage (LIG) which was initiated by our predecessors (2014/2015 student chapter office) was revived. This project realized in collaboration with the primary school of Laverune aims to promote geosciences to the future generations, enable the most knowledgeable to share their knowledge with the students.

The intergenerational exchange was created through meetings with the pupils, the Cerga that couldn't take part of the project this year. At first we met with the school to introduce the project and present our goals. We had come up with two themes centered on geology with the help of Suzanne Raynaud a retired researcher in geosciences, who guided us throughout both of our fieldtrips with the pupils and help us a lot with the pedagogy. The first field trip, themed “from the sediment to the rock” took place in Petit Travers beach along the Mediterranean coast, followed by a visit to Saint-Jean-de-Vedas stone quarry and finished in Peyrou Park in the center of Montpellier. The second fieldtrip themed about volcanism took place in Lodève Basin. There, we were able to explain the difference between a sedimentary rock and a volcanic rock. We completed this project by showing the pupils thin section of sedimentary rocks under polarized microscopes.

We also participated in the RIG (Resources & Innovative Geology) workshop co-organized by MEDYNA and TERINOV. This workshop brought together actors of exploration and production of natural resources to discuss about present and future prospects.

Collaboration with the Student Chapter of LaSalle Beauvais allowed the birth of the Kimmeridge project, where we took part in the three days in the field to study different outcrops displaying oil play in the region of Weymouth (Dorset, UK).

The student Chapter ended the year with its major project of an organized fieldtrip in Greece. The fieldtrip was mainly about mining with mineralization of Barite on Mykonos, as well as a visit of the ferronickel mine of LARCO. The participants also studied the sedimentation and the tectonics in the Gulf of Corinth. Panoramic observations were carried out to understand the present and the past of Gilbert deltas. The area represents an interesting analog to petroleum reservoirs. On the final day we organized a day of cultural visit in order to let the students to visit Athens and its famous Parthenon.

SPONSORS

I. RIG 5 et 6 April 2016

Through the internal organization, the student chapter financially contributed for half of the sign up amount for all first year master students in Exploration and Reservoirs Geology (GER). Furthermore, throughout RIG, the students of GER also hosted the SEG members from the Student Chapter of LaSalle Beauvais.

During this event, 160 people from 11 different countries in the field of geology were brought together, from academic and/or professional backgrounds. The conference took place for 7 days, allowing 37 speakers to present their work in various fields of exploration and exploitation of natural resources. For the occasion, the student chapter presented a poster promoting the activities and our goals for the year.

The speakers particularly insisted on the necessity of the coherence between oil and mining industry in order to come up with new effective techniques for exploration. The most representative example was the presentation from Dr. Lopez of the University of Montpellier on his mining exploration campaign; which resolved usage of ordinary methods in oil and gas exploration (High frequency Seismic acquisition).

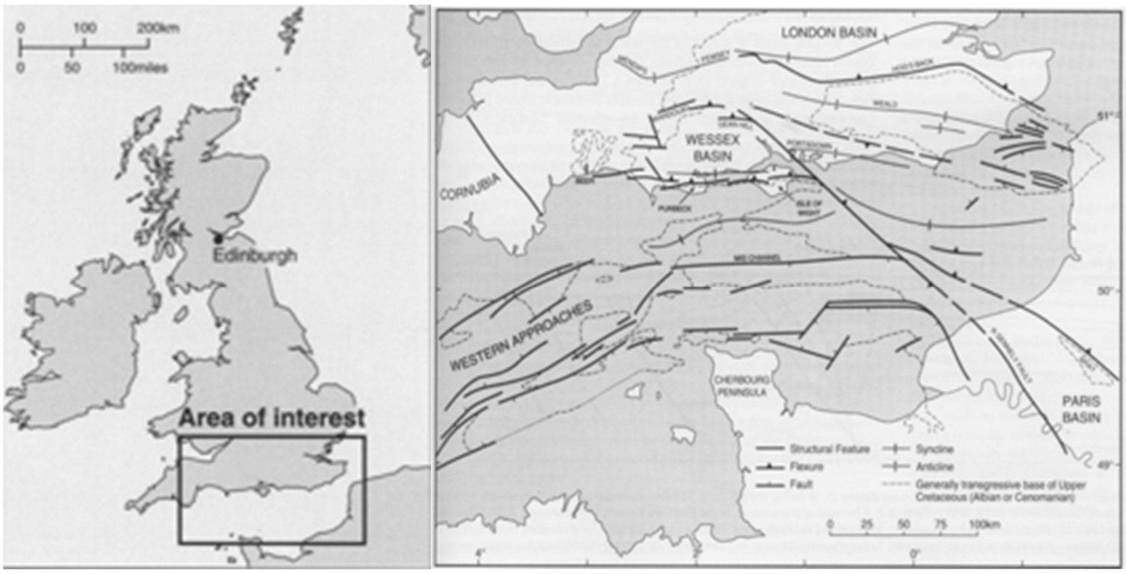
The depletion of the resources in addition to the current economic crisis has pushed the consultants to emphasize the necessity to deepen the exploration in the non-conventional fields. This issue will be the challenge for the younger generations, in terms of challenging techniques and enlargement of exploitable horizons.

The inventions, in example from Y. Daafi, H. Kaabeche, and K. Goodenough, emphasized on the use of new tools, especially information technologies, to highlight the resources all around the Mediterranean Sea. This will give profits to the business in search of similar fields, and also for the scientific studies lead by universities, facilitating the relationship of these two worlds.

II. KIMMERIDGE FIELDTRIP

II.1. Organization of the Field trip

This year's collaboration with the APPG Student Chapter of LaSalle Beauvais allowed five members of our student chapter to realize three days of fieldtrip in the region of Weymouth (Dorset, UK) to study the geologic history of the petroleum system with the objective to understand why the petroleum campaigns did not find huge hydrocarbon reservoirs in the Wessex basin.



Location of the basin of Wessex with the principal geologic structures

II.2. Geological study of the area

II.2.a. Day one

<u>CHARMOUTH</u>

-Source rocks: Blue Liassic, Jurassic inferior.

<u>SIDMOUTH</u>

- Triassic sandstone and fluvial system.
- Porosity and rock permeability.
- Well sorted red sandstone; cross-bedding.

WEST BAY

- Within formation of Lower-Middle Jurassic

- Superficial marine environment with shoreface deposits and traces of bioturbation.

Crude oil reserves have yet to be found in this region. This proposes a question whether this formation can be a good reservoir or not. The answer is this formation will unlikely be a good reservoir due to several issues:

1. Limestone strata developed barriers which in return created micro-reservoirs. This type of reservoir is hard easy to exploit.
2. Limestone strata are denser. There is a strong horizontal permeability and a low vertical permeability.

OSMINGTON MILLS

- Illite, Lower Jurassic Source rock.

- Intense bioturbation and shoreface deposits.

- Bioturbated Lower Cretaceous sandstone.

The students were able to observe the features of petroleum system, particularly the source rock. During summer, the oil seeps out of illite outcrops. Some petroleum campaigns have drilled in the area but have not encountered crude oil. Based on observation, the students can interpret that there was an issue with the top seal of the reservoir.

II.2.b. Day 2:

The morning of the second day, the students were observing the deformation of the Portlandian. In this place, the Purbeck formation was emplaced in an anoxic condition of a lagoon environment. The students were able to clearly identify blackshale.

DURDLE DOOR

- Purbeck formation strata
- Wealden Strata from Late Cretaceous
- Upper Greensand

The transgression of the system was observed. There is a detachment within a compressive stress regime. This probably marks the inversion.

There was a repetition of shale and limestone strata. Coal deposits from Lower Cretaceous were observed. Jarosite, a mineral that indicates the presence of living organism, were found during the observation.

Two main stages of regional tectonic are distinguishable. In the beginning there was an extension, which was followed by a compression. After Permian, the region experienced many rifting phases.

FOSSIL FOREST

- Observation of fractured beds of Purbeck formation.

- Deposition of marine carbonates.

- Breccia due to salt tectonics.

The presence fractured strata is explained either from salt diapirism and collapse of bedding and/or fault deformation.

To have an oil play, the trap has to be formed before fluid migration. In this case, the trap was formed through rifting during the higher Jurassic.

MUPE BAY

- Wealden facies of fluvial channels.

- Current and paleo seeps.

The two stages of migration are expressed by:

- The presence of Oil sands: black sandstone dating from the Albian which smells like bitumen. This is the first phase of fluid migration during the Albian thus explained the presence of crude oil. This information is very interesting because the traps where formed prior to the migration, during the Jurassic.
- Light brown sandstones. The oil comes from Blue Liassic source rocks. The deepest source rock has reached the "oil window" and thus migrated and possibly accumulated in the formation. The other younger source rocks could possibly be exploited.

<u>LULWORTH COVE</u>

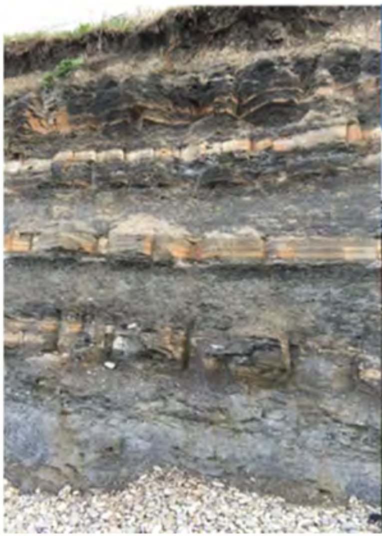
Observation of:

- Tectonic inversion
- Lulworth Crumple
- Purbeck strata / Portland Limestone
- Oil seepage
- Facies of Wealden (Lower Cretaceous)

II.2.c. Day 3:

KIMMERIDGE BAY

- Famous typical Kimmeridge clay outcrop
- Source rock facies.
- Oilfield in the Kimmeridge bay.
- The zone was discovered and exploited by Clavel in the 19th century. (Start of production in 1959)
- Produced only 80 barrels/day



The source rocks of the North Sea are generally Kimmeridgian. The area is a strato type. The students observed kerogen type 2 with TOC (Total Organic Carbon) of approximately at 10 %.

Pyrite ammonites were found which implies that there is no sulfur in these rocks. This is good news for the exploitation of the area. “Brent” crude has been produced in this field. The source rocks exploited are those from the Blue Liassic. Another reservoir called Corn brush or “broken limestone” also exists in the area.

II.3. Conclusion of project

During three days fieldtrip, the students were allowed to study the Wessex basin. They were able to observe factors that constitute the petroleum system, which are: source rocks, reservoir rocks, migration paths, proper migration timing and traps.

The source rocks which produce oil are from the “Blue Liassic” formation and generally from Jurassic. Often petroleum systems are named after the source rock and the biggest reservoirs. In the Wessex Basin, the most important reservoir is Cherwood. Therefore, the petroleum system is called: Blue Liassic- Cherwood. Consequently, there is a well-established petroleum system which exists in the region; however this possesses major issue as of why the system does not withhold huge amounts of oil. Numerous theories diverge to explain the reason oil and gas companies that lead the exploration in the basin did not manage to find large reserves of oil. The main problem is the timing. The traps formed before fluid migrations, part of which were destroyed and lost. The conservation of traps is a critical factor within a petroleum system. The absence of the important part of top seal in this petroleum system was also noted. However, the Blue Liassic produces some oil since for several years and it has yet to cease the production. To explain this durability, one theory suggests that the oil field is consistently supplied with the oil from rich source rocks of the “Blue Liassic”.

III. INTERGENERATIONAL PATRONAGE

III.1. Meeting the 4th Graders

Several weeks prior to the field trip, the representatives of the chapter met the 4th Grade pupils and their teacher from Laverune primary school. The representatives explained to them our academic background and the reason to study geology. Afterwards, the representatives gave explanation about the concept of time because the young pupils were stumbled to understand the concept of time beyond a human life span. Through this the representatives can understand the level of the pupils' comprehension of the history of Earth's formation and evolution.

The representatives also explained the idea of the projects and the field trips that they were going to take, in familiar places for most of them.

The brief presentation ended with the discovery of some samples, in example a specimen of Smokey quartz and Beryllium from Madagascar that made the children amazed and eagerly look forward for the various planned fieldtrips.

The children were particularly active and involved during this presentation, a lot of questions were asked about geology and the project. This was also an opportunity to share several experience, as some of the children said they collected minerals and fossils.

They seemed impatient to go out on the field with the chapter and said that they were motivated to find the most beautiful geological samples.

III.2. Field trips

III.2.a. Day 1: From the Sediment to the Rock

"From the Sediment to Rock" was the first outdoors trip that was proposed to the 4th graders. This field trip took place in three locations: (1) the shelled beach of Petit Travers in Carnon; (2) the Peyriere quarry in Saint-Jean-de-Vedas and (3) Peyrou Park in the center of Montpellier. These different stops enabled the students and Suzanne Raynaud, Geosciences researcher at the University of Montpellier, to ask themselves: where does the sand that makes up the beach come from? How can this unconsolidated sand become sandstone? What are those rocks used for?

- The shelled beach of the Grand Travers in Carnon

At our arrival at the beach, the students and their supervisors walked along the beach to study and search for clues and to observe what the sand is made up of. Armed with their eyes, their magnifying glass and godparent they managed to recognize some shells (clams, razor shells, etc.). They also established that the sand was constituted of different types of grains of different colors and shapes, and sometimes varying sizes. They asked themselves where the quartz grains come from, and what other elements constitute the beach in order to propose a transport model.

Some key observations were made in order to help the children to wonder the origin of the grains, on their size, rounded shape, and their colors. They also wondered why some grains were coarser than others.

- <u>The Peyriere quarry in Saint Jean de Védas</u>

The early Burdigalian deposits that constitute the Peyriere quarry represent the North East extremity of “the Juvignac” formation. This rock, well known as molasses, is a shelled limestone with fine grains, often used as cut stone since Antiquity. Of an ochre tint, it has been largely exploited for the construction of most Montpellier’s monuments, like the Arceaux aqueduct.

Using geology hammers, the students managed to sample the quarry in order to observe the grains with magnifying glasses. The correlation between the shells observed at the quarry and the shells found on the beach in Carnon enabled them to conclude that the depositional environments were similar. They were surprised to find beach environments kilometers away from the sea, on mainland. They then asked questions about the process of ocean currents, and how a beach environment could end up being located this far away from the sea. The representatives and supervisors had to make them understand that a landscape can change with time and that it records not only the human scale changes but also changes at a much larger scale of around millions of years. Therefore, they understood that in such a long period of time, a marine environment can become something totally different.

- <u>Peyrou Park</u>

The excursion ended in the quarry rocks in the city of Montpellier. The most beautiful example is the aqueduct of the “Arceaux”, linked to the spring of Saint-Clément, 14km away, to the water tower of the Peyrou promenade in the centre of Montpellier.

Our geology trainees were able to observe one last time the sedimentary rocks with a magnifying glass. They noted the presence of tool tracks left by the cut at the quarry, the rocks used for the construction of monuments were similar to those at the quarry.

III.2.b. Day 2: Volcanism

After one hour of bus and a lot of April’s fool jokes on our backs, we arrived at the Salagou Lake for the second day on the field with the 4th graders.

During this trip, the analysis made by the children surprised the chapter’s members. They participated in the discussion and managed to understand the general idea of volcanism. With the observation, the young geologists were allowed to distinguish two types of rocks. One rock was red, brittle and forming thin layers and with no grains visible with a magnifying glass. The other rock was dark, very hard with grains of different shape and size as well as holes. They learned about the rocks that composed the Salagou Lake.

After this observation phase and a well-deserved lunch break, the representatives concluded the observations made by the children and gave an explanation about the difference between the two rocks. These geology trainees being very perspicacious, we can even developed with them the depositional model of red shale in the Lodeve Basin.

The day ended with a microscope class inside the children's school of Laverune. The goal of this session was to allow the children to observe different rocks that they saw on the field (clastic, lacustrine and volcanic) with thin sections at a microscopic scale and some samples. They were able to see more details and also look at the variation of compartment at natural and polarized light (the multicolor effect was amazing for the children).

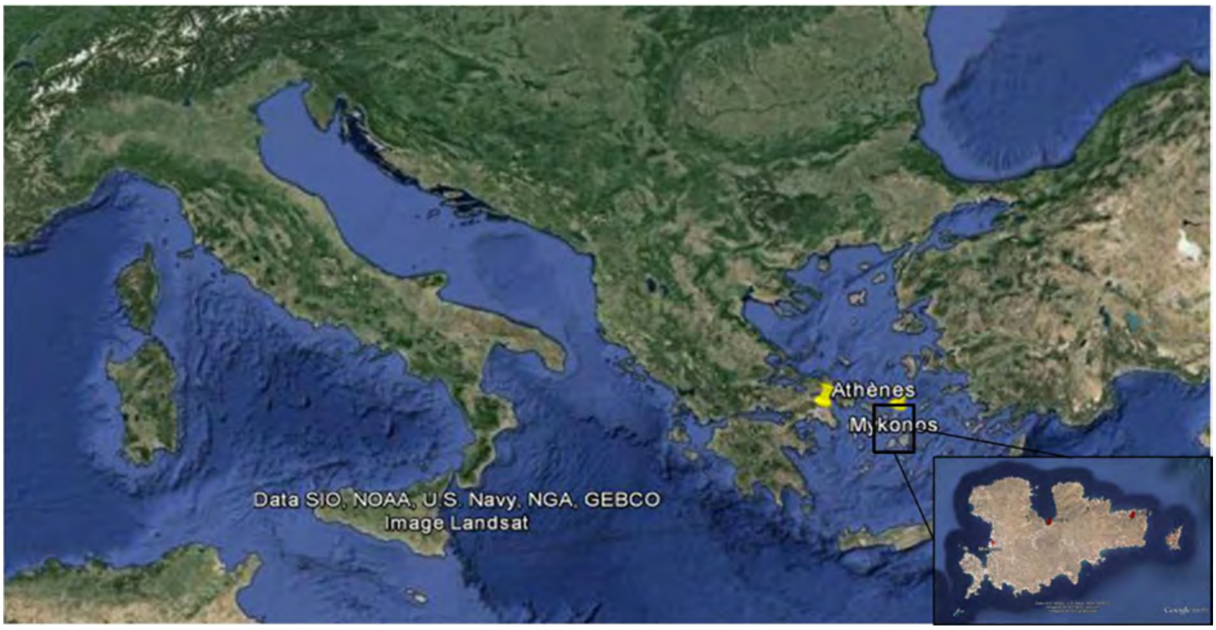
Finally, a global resume of the different environments was explained to the pupils.

IV. GREECE FIELDTRIP

IV.1. General Organization of the trip

IV.1.a. Program

The student chapter organized a trip from 20th to 27th of May in Greece. This excursion was split into several sites, with the first part of the visit in Mykonos Island to study Barite mineralization; the second was on main land under the guidance of Mr. Nicholas Skarpelis to study the lateritic deposits in a mining site of LARCO; and the third part was in periphery of Corinth bay with the study of sedimentary structures in a rift setting.



<u>Planning of the trip:</u>

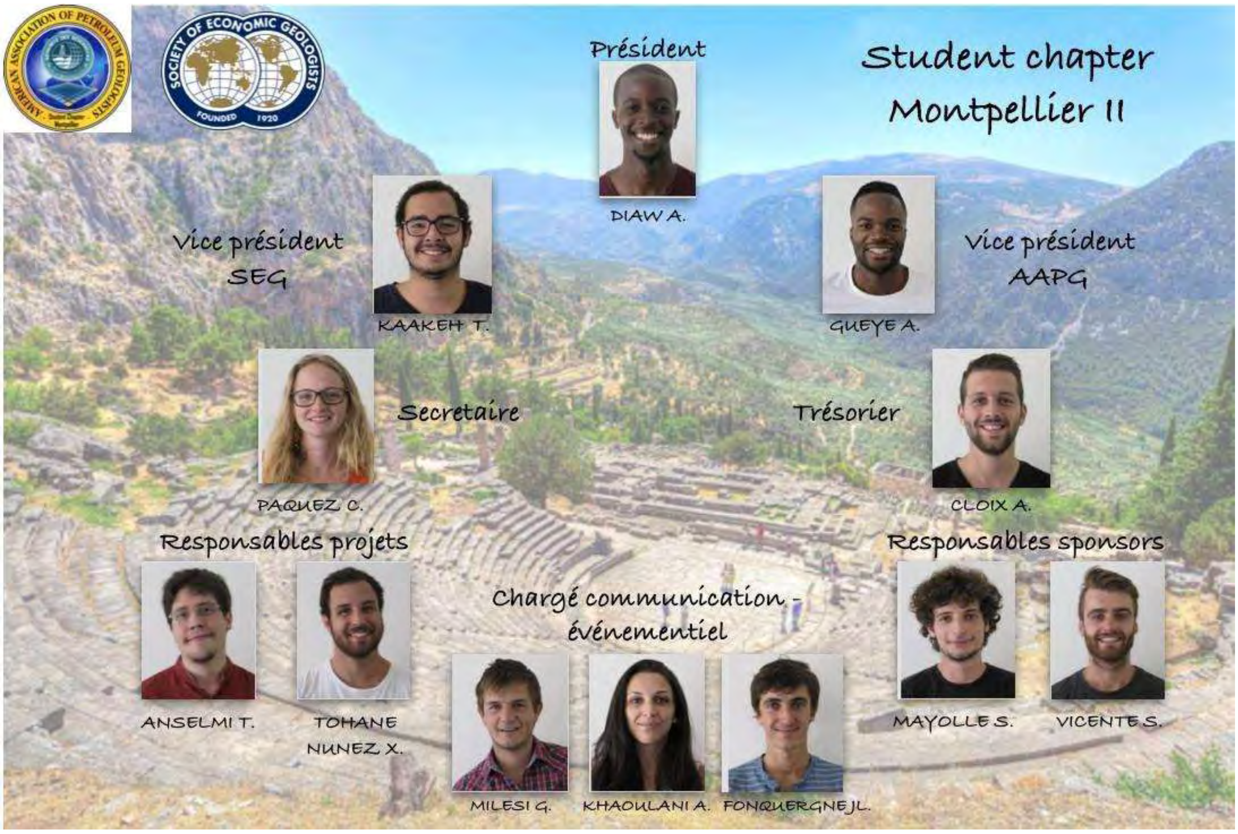
Day 1 (20/05/2016)	Journey to Mykonos Leaving at 7.15 a.m. from Paris, then transfer to Rafina port to arrive in Mykonos at 22.10 p.m.
Day 2 (21/05/2016)	Autonomy field trip in Mykonos Morning: Study of the outcrop in Pano Tigani Afternoon: Study of the outcrop in Cap Evros and Haros
Day 3 (22/05/2016)	Autonomy field trip in Mykonos Study of mineralization and oxidized iron, and the contact of mineralized

	vein and host rock Morning: First part study of the outcrop in … Afternoon: Second part study of the outcrop in … and try to characterize the contact
Day 4 (23/05/2016)	Journey to Athena Morning: Free session Afternoon: Transfer on a Ferry from Mykonos to Pyree port in Athena
Day 5 (24/05/2016)	Visit to LARCO Mine Morning: Welcome speech and presentation in the office. Study of different outcrops about the general organization of lateritic profiles and also the accumulation process of exploited Nickel. Afternoon: Visit on pyro-metallurgy site of the company and discussion of its impacts to the environment
Day 6 (25/05/2016)	Autonomy field trip in Corinth Bay Study of the progressive extensive system and the deposition for future hydrocarbon reservoirs
Day 7 (26/05/2016)	Cultural visit Free session trip for the students to visit the town; try the specialty culinary and visit the heritage of Greece; especially the Parthenon
Day 8 (27/05/2016)	Return journey to France Departure at 5.30 a.m. to arrive in Paris at 9.00 a.m.

IV.1.b. List of the participants

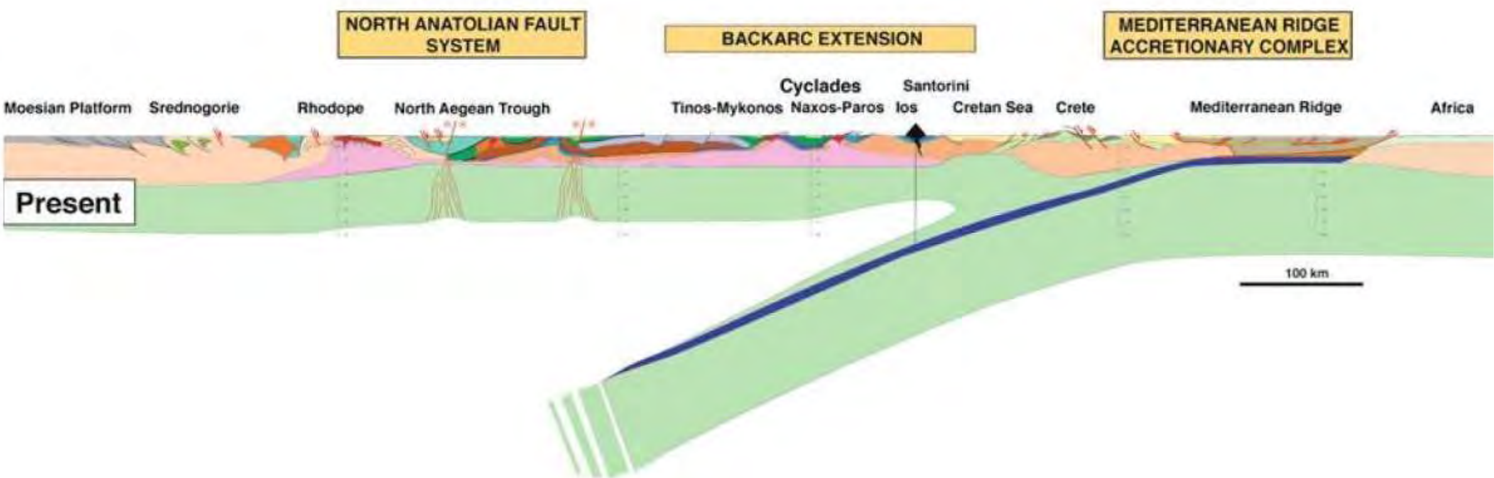
The trip was organized for around twenty people, and this year the class of Master 1 GER could participate, including members of the Student Chapter, with an exception of a student and a teacher, who were not able to come for different justified reasons.

LIST OF PARTICIPANTS	
NAME	Function
DIAW Abdoulaye	SEG-AAPG President
KAAKEH Thomas	SEG Vice President
ANSELMI Thomas	Project manager
TOHANE NUNEZ Xavier	Project manager
PAQUEZ Camille	Secretary
MILESI Gaetan	Event coordinator
FONQUERGNE Jean-Lucien	Event coordinator
CLOIX Anthony	Treasurer
VICENTE Simon	Sponsorship coordinator
MAYOLLE Sylvain	Sponsorship coordinator
GUEYE Anderson	AAPG Vice President
MAKENGO Dondi	Active Member
KHAOULANI Amal	Active Member
ASTOUX Aymeric	Active Member
JACOB Mathilde	Active Member
DUTEQUE Sebastien	Active Member
RICHARD Johan	Active Member
BERNARD Remy	Active Member
Melania Seta Dhesti Wijayaningsih	Active Member


Président
Student chapter
Montpellier II
DIAW A.
Vice président
SEG
KAAKEH T.
Vice président
AAPG
GUEYE A.
Secretaire
Trésorier
PAQUEZ C.
CLOIX A.
Responsables projets
Responsables sponsors
Chargé communication -
événementiel
ANSELMI T.
TOHANE
NUNEZ X.
MAYOLLE S.
VICENTE S.
MILESI G.
KHAOULANI A.
FONQUERGNE JL.

IV.2. General Geology of Greece

The regional geology of Greece is marked by the subduction of African plate underneath European plate in Late Cretaceous. The units underwent burials during subduction and High Pressure in Low Temperature metamorphism. This metamorphism is dated around 50 to 35 million years locally and allowed the creation of blue schist (Cycladic blue schist). The withdrawal of the slab (rollback) allowed the migration of the front side of the subduction to the south. This consequently transfers the metamorphic rocks in back-arc zone and the creation of an extensive back-arc region from 35 Ma onwards. Since this period until Tortonian (Miocene, 8 Ma), the extension allowed the exhumation of metamorphic rocks (Metamorphic Core Complex) with detachment system of North Cycladic. During this period, back-arc magmatism marked the region of Cyclades (Tinos, Delos, Mykonos, Ikaria, Serifos, and Naxos). In this extensional domain, several barite, base metal and gold deposits developed related to syn-tectonic granitoids as in Mykonos Island (Greece).

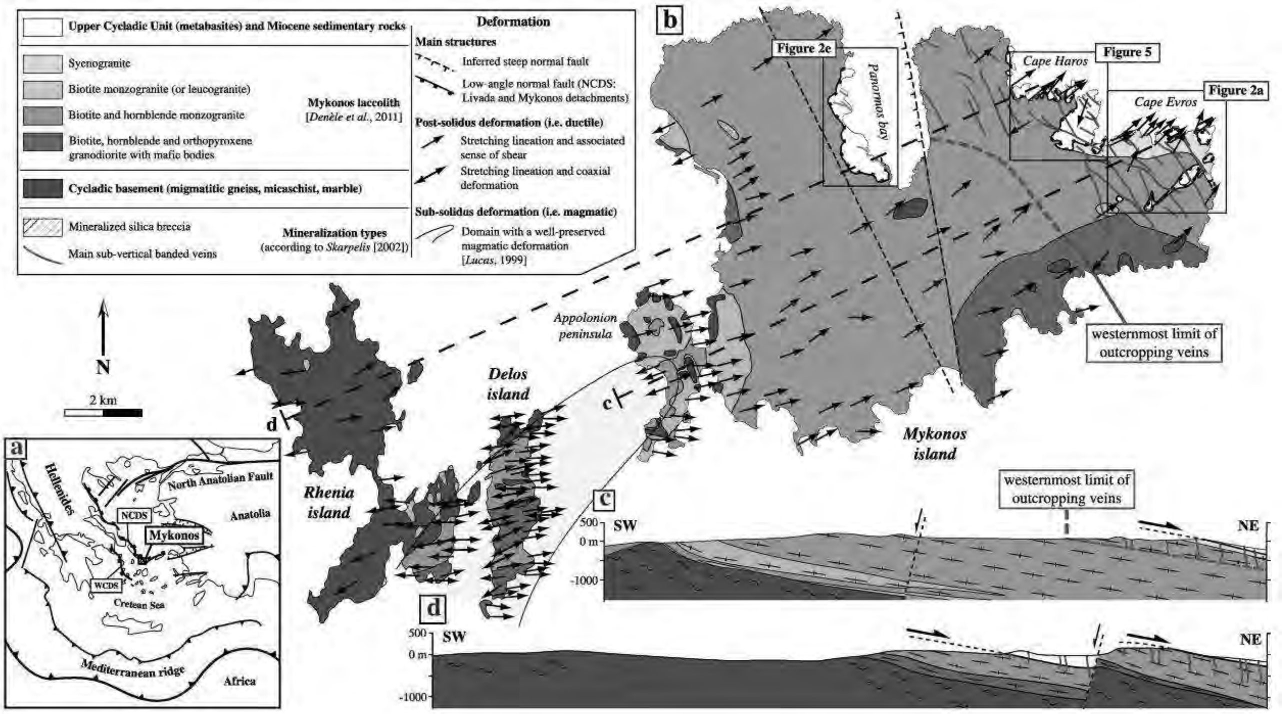


Extensional system in Greece (after Jolivet and Brun, 2008)

IV.3. Mineralization study in Mykonos

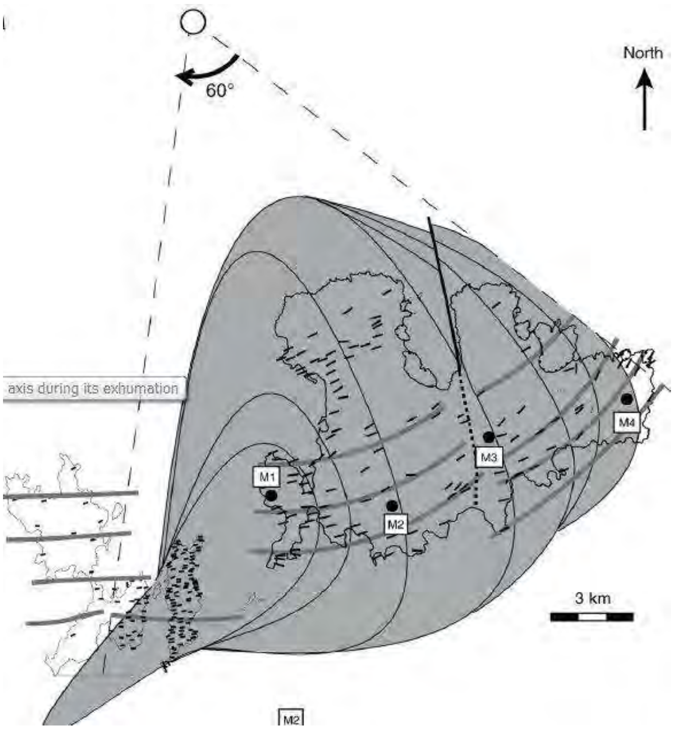
IV.3.a. Geological context of Mykonos

Mykonos Island is manly constituted by a 13-10 Ma syn-extentional I-type granitoid that intrudes a magmatic dome [Brichau *et al.*, 2008; Denèle *et al.*, 2011]. The NE-SW back-arc extension is expressed on this island by two main shallow-dipping shear zones belonging to the North Cycladic Detachement System (NCDS): the top-to-the-NE Livada and Mykonos detachments [Lecomte *et al.*, 2010]. In the regions where the NCDS crops out, numerous sub-vertical banded barite and sulfides veins occur [Skarpelis, 2002]. The extensive system cuts the region with N-S oriented fault localized in the NE of the island.



The deformation in Mykonos Island (after Jolivet and Brun, 2008)

The NCDS allows the mineralization of Barite and iron oxides (Hematite-Goethite). These mineralization are essentially found near



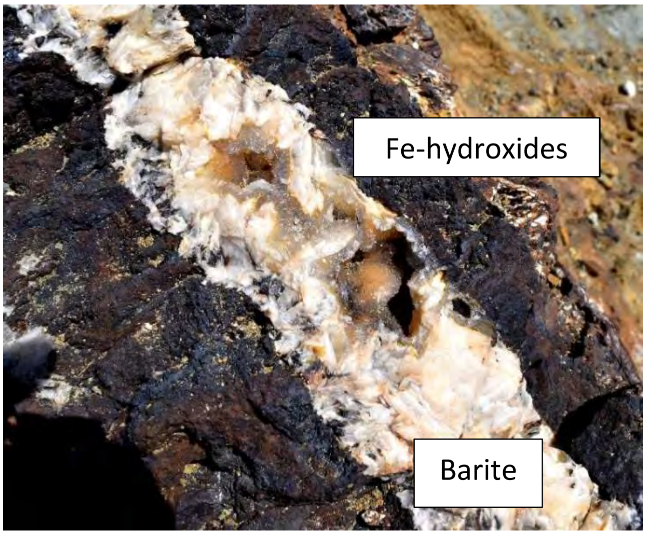
<u>The laccolith in Mykonos:</u>

Laccolith is a mass of intrusive rocks, rounded at the top that and insinuated in a sedimentary series. The melt does not reach the surface and stops in the lithosphere to distribute it laterally between the parallel layers.

In Mykonos, the rise of laccolith causes a sinistral strike-slip along the accidents in the region.

Laccolith distribution (image in the left, after Denèle et al, 2011)

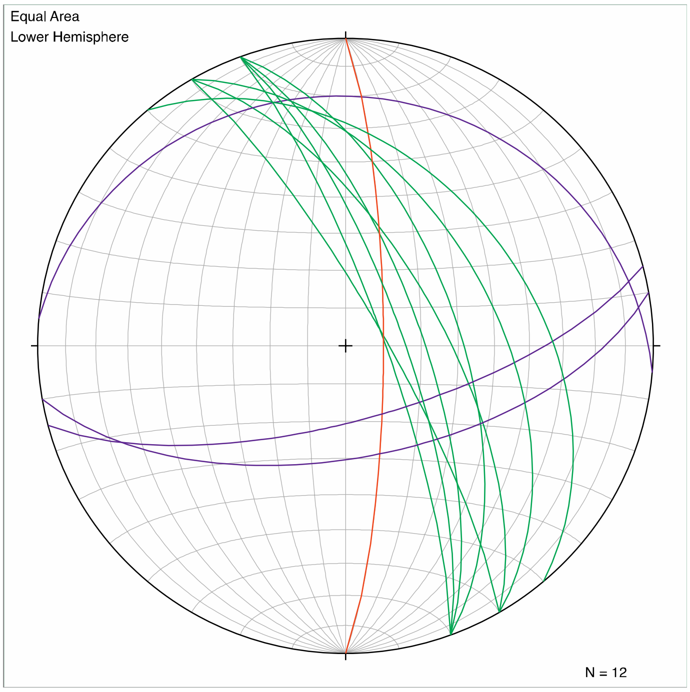
IV.3.b. Study in Havros and Evros.



A series of NW-SE oriented veins affect the north eastern part of the island. This orientation is compatible with the Aegean extentional phase. These veins can reach several meters of thickness and extend to several kilometers.

Different faults are measured on the playa Favos, where the fault comprises of Orthogneiss bluish with oriented Potassic Feldspar, a N55E lineation and a N95E 20N Foliation.

Direction - Dip	Component of the fault	Mineralisation
N150E 65NE	Normal	Fe
N160E 70 NE	/	Fe
N150E 80NE	Normal	Fe + Baryte
N95E 20N	Slip	Silice
N160E 60NE	/	/
N160E 80NE	/	HOFE
N0E 80E	/	/
N80E 60S	/	/
N75E 70SE	/	Fe
N140E 40NE	/	HOFe
N150E 50NE	/	HOFe
N160E 75E	Normal	HOFe + Baryte
N130E 40NE	/	HOFe+ Baryte



This stereonet resume the data collected, the green trace is the normal fault with majority HOFe and Barite. The purple trace is another type of fault while the red trace is a slip fault with silica.

In this open vein, which was exploited, copper oxide was visible in the Marcasite. These oxides seem to pre-date barite mineralization, thus indicating the presence of other sulfides.

IV.4. Visit of LARCO G.M.M.S.A Mine

IV.4.a. Presentation of the company

LARCO G.M.M.S.A is a Greek mining company which was established in 1963 by Bodossakis. It is one of the five largest ferronickel producers in the world and the biggest Ferro-Nickel producer in Europe. The company is owned by the Greek government with 25% share. The company is engaged in the exploration, development, mining, smelting and marketing of its products globally. LARCO owns Servra Lignite mine, Kastoria mine, Aigos Ioannis mine, and the smelter as well.

The company's production constitutes 1% of global nickel production, 5% European demand in nickel. In the Greek economy, the Nickel contributes to 0.10-0.15% of Gross Domestic Product. Its sales consist 1% of total Greek exports.

The company produces 19.000 thousand tons of nickel annually in form of granulated Nickel which is demanded because it is perfect for precision control in feeding to arc furnaces and converters.

IV.4.b. Occurrence

The extracted nickel is found in area characterized by the presence of ophiolites. When the nickel is found in the ophiolites, it has no economic value, as it is scattered in the rock matrix, mainly in Olivine minerals. Therefore, enrichment is necessary so it can be economically interesting. From here on the sedimentation processes come into play, as the nickel-rich ophiolites are altered through different processes explained below which allow higher grade concentrations to occur further up the lateritic profile.

<u>Volta location:</u>

The studied area is marked by different rock formations. It is composed of Upper Cretaceous transgressive carbonates (Cenomanian-Turonian) which constitute the cover. Ultramafic rock units (Harzburgites, Lherzolites). The ophiolites are of Late Jurassic with the exact age determined to be 160Ma trough Zircon age determination. They belong to the Tethys ophiolitic complex.

The mineralization is observed in between the Cretaceous and ophilitic complex. This mineralization process occurred a few million years before the marine transgression. Olivine, Serpentine and Pyroxene are weathered into clay minerals. Most of the Ni is incorporated in Smectites called Nontrolites. Observations of saprolite of the profile reveal that this part is composed of altered bedrocks of serpentine, boxworks features, and other associated minerals. These boxworks textures are with veins filled with Quartz or Calcite.

Boxworks observed in the Volta location (picture in the left)

It takes 1Ma to get a 10m laterite profile. The Ni is at a 3% grade in Hematite and Goethite minerals. Sillicrates were observed in iron rich sediments. It is a pedogenic rock which is formed in a lateritic profile due to the replacement of smectite and serpentine and serpentine with Quartz.

The Ultrabasic rocks were obducted and exposed to the continent. During Cenomanian, transgressive system developed in the area and eroded and deposited carbonates materials, with lateritic sediments. The alteration resulted FeOOH and Nickel. The nickel deposit itself comes from two different processes, the first type comes from the weathering of olivine, associated with iron oxide deposits, and the second type comes from the replacement of Mg due to chemical reaction. The alteration process generates the deposit of nickel. Some of the deposits are eroded, and the reworked nickel is deposited on top of the karstified limestone. From the alteration process, secondary minerals can also be found in the area, for example Garnerites (a variety of nickelliferous chlorite). The alteration profile is represented in the next figure.

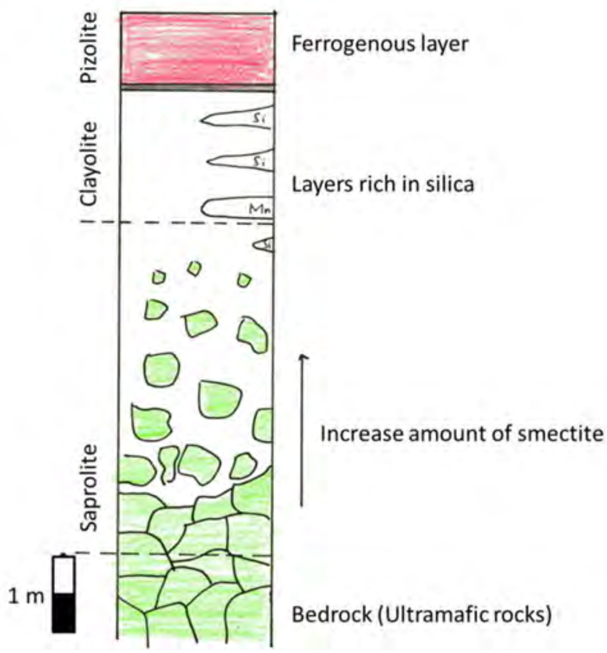


Figure of lateritic profile in altered formation

In Nici mine, the students observed Karstic Nickel in Triassic-Jurassic limestone, which is the result of the erosion of the lateritic profile (this profile being at a higher altitude than the karsts). In this area there is 3Mt at 0.9% Ni.

HOW the ore is extracted:

- **Underground mining** using a sub-level caving method. Access to the deposit is carried out with horizontal calcareous galleries and spiral ramps. The main phases are the drilling, the charging of drills with explosives and their firing, the collection of the produced ore and the support of the galleries. The produced ore is transported to the surface by electric railroad.
- **Surface mining** while combining open and closed pits. The height of the benches varies between 12 and 15 m, with the width depending on whether they are active benches or close to decommissioning. In the beginning, they were around 25 m wide, decreasing to around 12m before decommissioning. Stripping is performed by using explosives while cutting with bulldozers and other mechanical equipment. Extracted ore is stored temporarily in piles before transported for crushing and separating. The magnetic portion of the ore is led to the stacker system and on to the homogenization yard. The homogenized ore is loaded and transported to the smelting plant, where it is weighed and fed to the kilns for further processing.

IV.4.c. The pyro-metallurgy and impacts

The smelting plant is located in Larymna. The materials mined in the field are brought to the smelter to be processed. The first part is the separation of the valued grains from the polluter. The basic production line consists of 4 rotary kilns, 5 electrical furnaces and 2 OBM-type converters, with a capacity of 50 tons of metal each. There are also secondary installations, with 2 units for the production of oxygen and nitrogen, grinding units, and magnetic separation units. The plant operates 24 hours a day, 365 days a year, producing high-purity, low-carbon ferronickel granules, used exclusively in stainless steel production. The plant processes the mined nickelferrous ores (laterites) to produce ferronickel with 18%-24% nickel content.

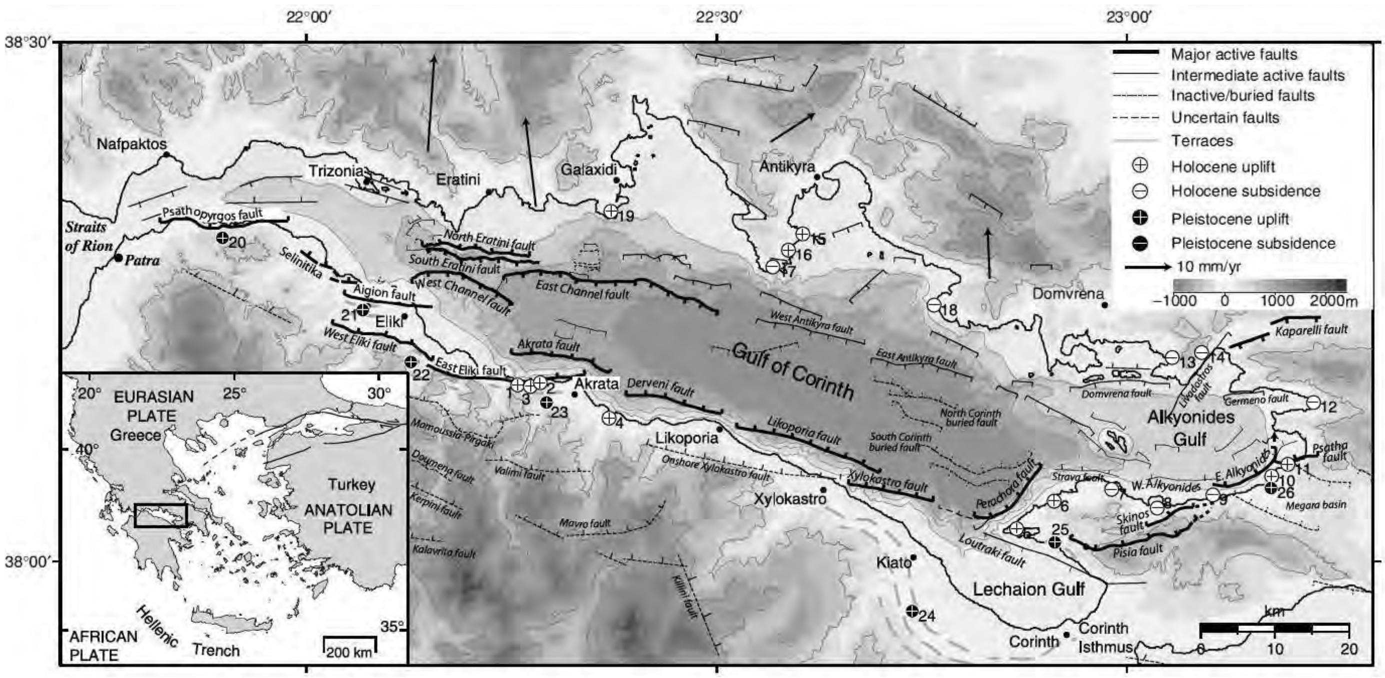
The polluter is immediately recycled or disposed in a secured place. In addition to the polluter, the processing and the production leave residues. To minimize the pollution impact, to the land and especially to the ocean nearby, LARCO has designed to maximize the recycling effort and bury the non-usable material in certain agreeable sites.

The total quantity of ore processed per year is 2,500,000 tons, equating to an annual ferronickel production of around 18,000-20,000 tons.

IV.5. Study of Corinth bay

IV.5.a. Structural study

Located in the eastern part of the mainland, Corinth bay is presented as a rifting environment in the back-arc extension. This rift, started around 5 mA and still active but presented in normal fault oriented to WNW – ESE.

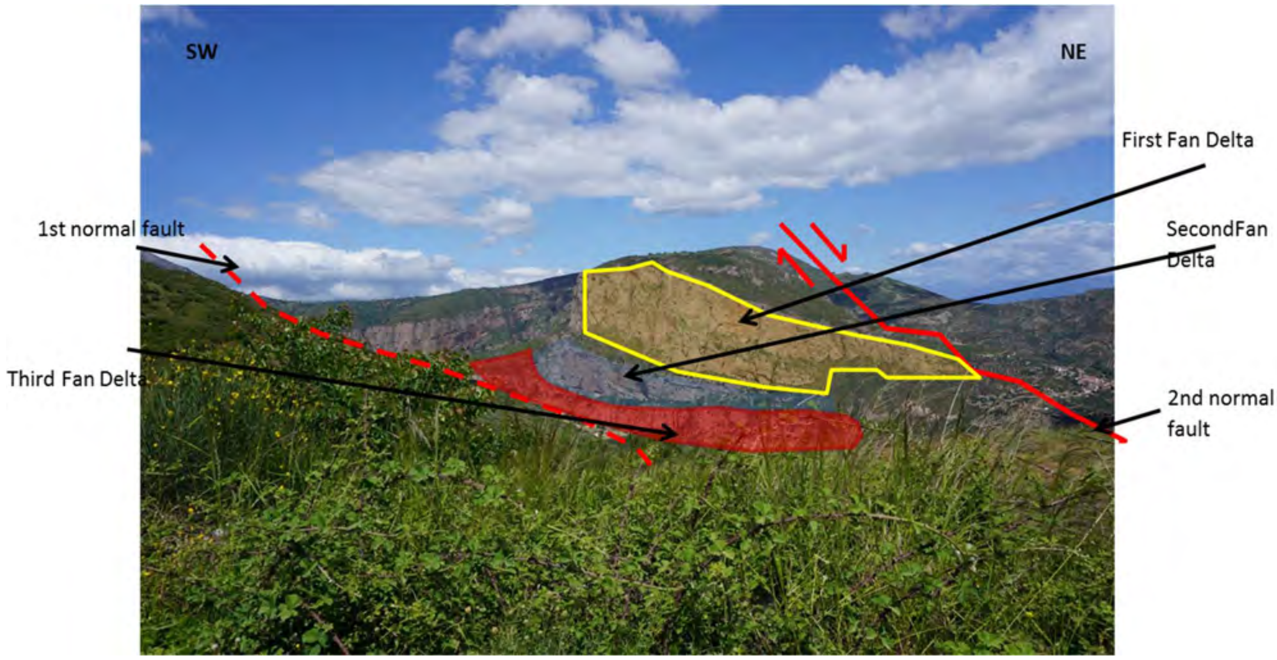


Structures in Gulf of Corinth (after Bell et al,2009)

IV.5.b. Sedimentology of faults

Panorama of the zone reveals the characterization of coarser sediments to finer ones in the direction to the basin. The Corinth basin is generally characterized as a future possible oil reservoir, because it reassembles all the characteristics that are necessary to their definition. First of all, the basin presents normal faults, as seen on the picture below. This picture puts into evidence the normal faults that will be able to serve as drain, as they do not remobilize clays or any other facies that could be used as a barrier.

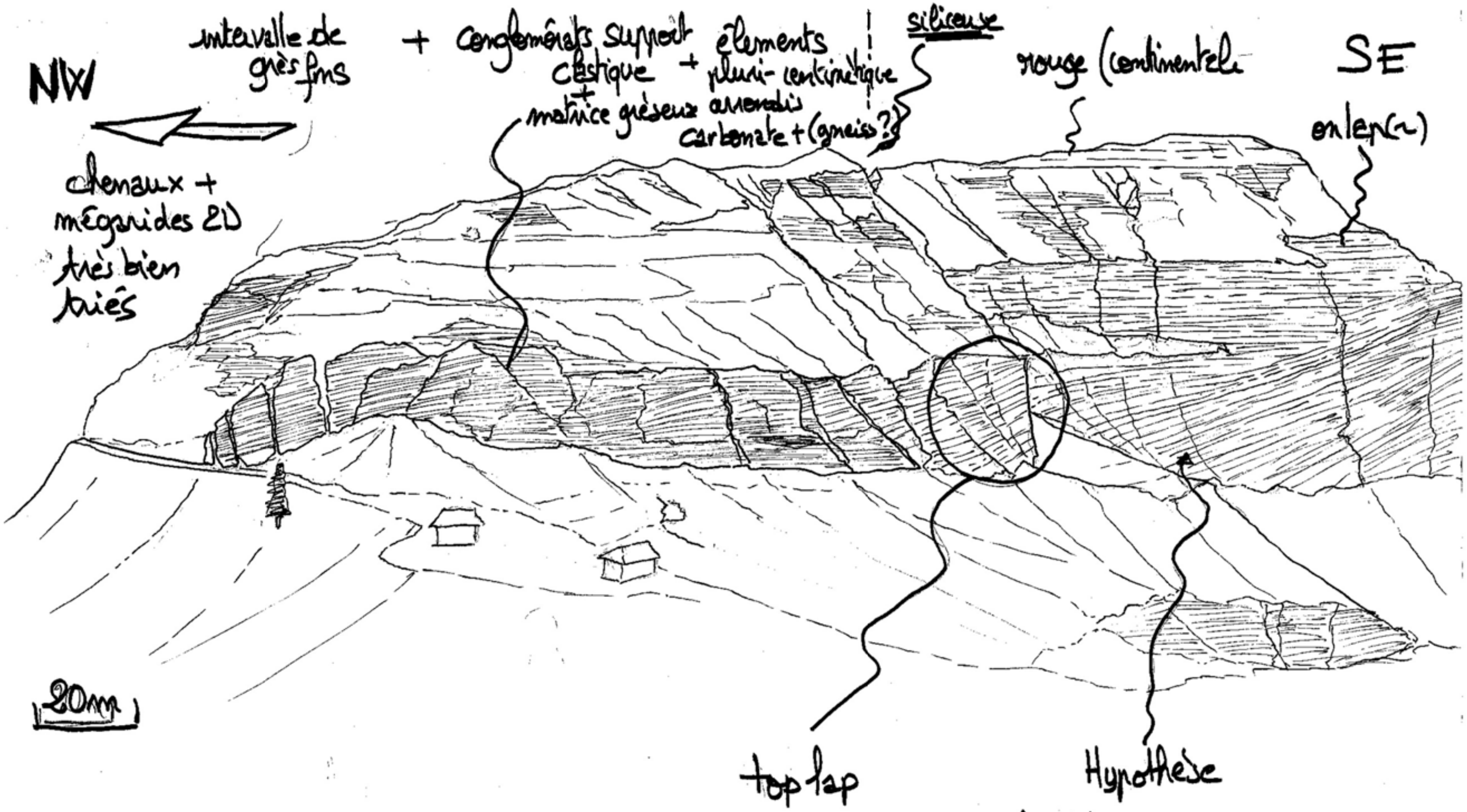
The encountered rocks are mainly conglomerates that possibly become good reservoirs rocks with high porosity and in huge volume. Conglomerates exist as part of fan delta and were observed with thickness of over 10 meters in one part of the stops. The fragments were ranging from several centimeters to tens of centimeters with coarse matrix.



Panorama of Corinth bay with normal faults and coarse sediments

A petroleum reservoir is defined with its faults, its reservoirs, its source rocks and its seals. Nowadays, we can only distinguish the reservoirs, source rocks and drains. Based on bibliographical study and observation, the reservoirs are composed of fan deltas, distinguished in the picture above. They mainly are composed of conglomerates with matrix that allows fluid circulation. The normal faults seen on the outcrop do not include clays thus can be considered as drains. Source rocks developed in other part of the basin and cannot be observed from the designed outcrop study. However, the lack of top seal affects the reservoir potential, as it is not yet effective. In effect, the fluids cannot be trapped during the migration.

There are two missing things of the petroleum system in the current extensional basin in the Gulf of Corinth, the aforementioned top seal and the depth of the source rock to support the maturity into hydrocarbon. Similar situation were observed in the Lodeve Basin, where all the possible elements necessary for forming a good reservoir present, but it misses a top seal and a regular and matured layer of source rock, thus the hydrocarbon seeps out from the formation without accumulation. However since the rifting is still in its early stages we can hope for good reservoir quality in a few million years.



Panorama de Kervites

I fan delta avec progradation
II Suivi transgression par jeu de failles normal... relative

V. Cultural Visit

The last part was dedicated to visit the capital of Greece, Athena. The rich and ancient Greek culture, the unveiled city and historic buildings are presented for the students.

The visit to the Parthenon, national museum of the antiques and Hespaïstos temple enriches the students' culture recognition for this country. Although not related to geology, this day contributed partly to the success of the trip as it left us with long lasting memories.