SUBITO !

E-newsletter #1

by

Carlos Fernández-Garcia, Nicholas Schliffke

and the collaboration of ESR

December 2016

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INTRODUCING THE SUBITOP FELLOWS

ESR 1 - Arthur Briaud

University: University of Roma III (Italy).
Project title: Unravelling of subduction zone topography through analogue and numerical modelling.
Scientific background: Tectonics, structural geology, analogue modeling, mantle processes.
Why this project?: My project matches perfectly with my wish and my quest for knowledge in the field of modelling, in particularly in the geodynamic context.

ESR 2 - Antoine Auzemery

University: Utrecht University.
Project title: Analogue and numerical modelling of topographic response of subduction initiation at passive margins.
Scientific background: Structural geology, Basin analysis and Tectonic inversion.
Why this project?: It is in the continuity of my research interest, and the research team in the university and in the Subitop program offers the best framework to collaborate and diffuse ideas.

ESR 3 - Carlos Fernández García

University: Université Rennes 1.
Project title: Deformation processes of lateral slab tearing, from crust to mantle.
Scientific background: Geology and Geophysics.
Why this project?: The pursuit of knowledge has driven me to a research career. The bachelor and Master, have given me the opportunity of study tectonics, which –in summary- interests me. This project will allow me to better understand one of the main tectonic processes, subduction.

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ESR 4 - Jessica Munch

University: ETH Zurich.
Project title: 4D geomorphological-thermo-mechanical modelling of orocline evolution.
Scientific background: Physics, Chemistry and Geophysics.
Why this project?: I did not know much about oroclines before starting this project but found those topographic features quite intriguing. I was interested in subduction processes but what I really appreciate in this project, it is that it does not only involve the study of deep processes, but also a coupling with surface processes to understand the formation of oroclines.

ESR 5 - Kittiphon Boonma

Institute: Institut de Ciències de la Terra Jaume Almera (CSIC-ICTJA), Barcelona.
Project title: Slab tearing, vertical tectonic motions, and the Miocene marine gateways across the Gibraltar Arc.
Scientific background: BSc in Geophysics, MSc in Applied Geophysics.
Why this project?: The project is closely related to the field of my master thesis, which was a change within geoscience fields (I used to be in the exploration section) that I am glad I took.

ESR 6 - Kristof Porkolab

University: University of Utrecht.
Project title: Wide rifting in backarc basins: application to the Aegean natural laboratory.
Scientific background: geology in general, my main interest and expertise is tectonics and structural geology.
Why this project?: 1) Exciting scientific question that fits my interest 2) Possibility of joining to an international group of people with similar interest 3) Opportunities in scientific meetings, learning opportunities, and travelling.

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ESR 7 – Ajay Kumar

University: Institute of Earth Sciences Jaume Almera, Barcelona.
Project title: Topographic response to lateral changes in subduction polarity.
Scientific background: Earth Sciences, Geology, Geophysics and Seismology.
Why this project?: . In this project, I am supposed to do 2D petrological-geophysical modeling of crust and upper mantle. This involves the integration of seismic, potential field and petrological data and this is one of the main reason why I opted for this project. I will get to learn different fields in this project which I hope will enhance my skills for the scientific career.

ESR 8 - Nicholas Schliffke

University: Durham University.
Project title: Subduction of land-locked basins.
Scientific background: I received both my Bsc and Msc in Geophysics at Muenster University (Germany). The topic of my master thesis was on convection in Earth's mantle and the possible creation of 'Large low shear velocity provinces' (LLSVPs).
Why this project?: This project combines geodynamical modeling of processes related to the surface and, at the same time, is located in a English speaking environment. This was just what I was looking for!

ESR 9 - Joost von den Broek

Institute: University of Oslo.
Project title: The role of subduction in the formation and evolution of continental slivers and microcontinents.
Scientific background: BSc and MSC in Geology, specialized in tectonics and analogue modelling at Utrecht University.
Why this project?: I applied for this particular SUBITOP project because of the multidisciplinary nature of the project, the interesting research question and the chance to learn new techniques, specifically numerical modelling.

ESR 10 - Manar Alsaif

University: Montpellier.
Project title: Upper plate deformation in response to varying rollback velocities.
Scientific background: Geologist.
Why this project?: It is an interesting aspect that is relevant and has not been studied before. Also, because it has field work!

ESR 10 – Ehsan Kosari

University: GFZ / FU Berlin
Project title: Topographic signals from the shallow megathrust seismic cycle.
Scientific background: Active Tectonics and Earthquakes; Seismic Hazard Assessment; Analogue Modelling; Structural Geology
Why this project?: 1) Importance of megathrusts evaluation in terms of seismic hazard 2) Integrating surface and subsurface data and applying the data for analogue and numerical modelling 3) Chance of joining the professional and international group making this project unique.

ESR 12 – Richard Ott

University: ETH Zürich.
Project title: Uplift rates and mechanisms in the Hellenic Subduction Zone.
Scientific background: Geologist.
Why this project?: The project combines a lot of different fields of geology and techniques to move from small picture outcrop sedimentology and dating methods to large scale subduction zone dynamics and earthquake hazards.

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ESR13 – Malwina San-José

University**:** Università Roma Tre (Italy).
Project title**:** Modelling uplift, erosion and surface evolution of the Central Apennines of Italy and Dinarides.
Scientific background**:** Solid Earth and Geophysics.
Why this project?: The project was an immediate eye-catcher for me, as it combines field and lab work (e.g. thermochronology) and numerical models. This multidisciplinarity and multi-scale approach applied to a highly debated subject like the mediterranean geodynamics was more than I could dream of!

ESR 14 – Boris Gailleton

University: University of Edinburgh.
Project title: Topographic response to cessation of subduction in the Carpathian mountain range.
Scientific background: Geology and Geophysics.
Why this project?: I then choose this project by interest for this wide problematic involving field work, numerical modelling, topographic analysis and geological work. I also really enjoy the fact that the cessation of convergence/subduction is progressive in the Carpathians that should allow us to observe intermediate stages in this process

ESR15 – Sam Wilson-Fletcher

University: GFZ / University of Potsdam
Project title: Substrate controls on topography and erosion
Scientific background:
Bachelor's in chemistry, master's in condensed matter physics.
Why this project?: Trying to understand what controls the shape of landscapes is a lot of fun. Also, I love rocks (and rock climbing), so exploring the relationship between rock properties and topography was an obvious choice.

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Niels Hovius is the SUBITOP coordinator. He is a geoscientist who has been working for decades in different topics related to the geosciences, such as geomorphology, geochemistry, geophysics and active tectonics. We had the pleasure of meeting and interviewing him…

What is your scientific background?

By training I'm a geomorphologist and geologist. I'm interested primarily in the dynamics of the Earth's surface, and you could split this into individual processes. Just the mechanics of these individual processes, or much more- I'm interested in the interaction of these processes and the role these processes play in bigger systems within our planet. It can be geophysical or geodynamical systems such forming plate boundaries and building orogens but it could also be the connected atmosphere-ocean system coupled through bio-geochemical cycles. **So I try to study, understand and quantify erosion processes, and its role in mountain building and in those global biochemical cycles.**

What was you most favorite country to work in?

That's a very difficult question to answer. There are really charming things about some countries and you find there are less likeable things about countries. It very much depends on how you looked at the

places and what you expect. So, for example I do a lot of work in Taiwan, and I really like Taiwan for many reasons: scientifically it's an exciting place because both the geophysical processes and climatic processes are really boosted, they go at an enormous rate and therefore the topography develops very fast. This exposes it to rather extreme conditions and makes it a very thrilling place. It is also an exciting place because there are many measurements already available. It is also culturally exciting, the Chinese settled and occupied this place, and there are several different aspects of Chinese culture that are very well expressed and preserved in Taiwan that are very easy to access and enjoy. It's a very difficult place to work because it's not always pretty and because you have to bridge those cultural boundaries. A similar place, but less well documented and very pleasant to work is New Zealand, which is beautiful. Nature is untouched in some

parts, especially in the South of the country and the West of the South Island. It is just beguiling, original and beautiful, but there's no data available, so that makes a difficult place to quantify things. Maybe a place that is less well-known, but is very exciting and really has a special place in my heart, is Papua New Guinea, which is a large island on the equator. It shares many aspects with places like Taiwan, but it is settled by people who have profoundly different history from ours, and to travel through Papua New Guinea, with all its difficulties and hardships, is really one of the outstanding memories of my professional and personal life. **If I would have to choose one, then I would actually go back to Papua New Guinea, simply because that is a place where scientific discovery goes hand-in-hand with enormous cultural discovery and with very exciting adventure, it's that combination that I really love.**

"Claudio said: "*I do this once, and someone else has to take over*", and it came to me. So this makes SUBITOP part of the tradition."

How did you come to SUBITOP?

SUBITOP is a part of something bigger, which is called Topo-Europe. Topo-Europe is a group of people, a group of geomorphologists and geophysicists who worked for more than a decade. They have worked together to understand the links between shallow processes and deep processes and they work not only in Europe but also elsewhere. It's a European consortium which is coordinated by people (S. Cloetingh, S. Willett, C Faccenna) in which I also play a coordinator role. This consortium tries to have a student activity at all times, for example an ITN. We had an ITN which was created and coordinated by Claudio Faccenna and that ran out in 2014. We decided to try again and were first time lucky. It's very hard to coordinate an ITN, it's a lot of work, so Claudio said: "*I do this once, and someone else has to take over*", and it came to me to try for renewed funding. So this makes SUBITOP part of the tradition and I hope, in time, that all the ESRs will become aware of this tradition and become an integral part of the Topo-Europe community. It is really quite a tight-knit community which will be, I think in many ways, of use to the SUBITOP students because it provides a future home for projects and for talents.

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Why does the project focus on subduction?

Subduction is one of the key tectonic processes, it's not the only tectonic process, and Topo-Europe is bigger than any one particular process. It simply looks at any geodynamic process and its expression at the surface. It is especially that expression at the surface, the link between the shallow and the deep, that is fundamental to Topo-Europe. In Topomod, the previous ITN, we didn't have a focus on a particular process and we found it quite difficult to maintain coherence of the consortium, simply because people were looking at numerous things and it was difficult to see the links between individual projects. So we decided to focus on a particular tectonic setting. **It makes sense to focus on subduction in Europe because much of the topography of Europe is profoundly affected by, and really a construct of, subduction and subduction related processes.** There are four major subduction systems that are active or have recently been active within Europe. Elsewhere in Europe, subduction has played a really important role deeper in the geological past. So to focus on subduction tectonics means that we allow for a tightly knit network of projects. **By focusing on Europe, people are working close to each other, they are neighbors, they share not only questions, but they can share observations and data sets in a rather confined theater.** We hope this will make for a better coordinated and connected network. Actually when I look at how the students interact at this very early stage, it's already clear that that was a good plan and we are going to see a group of young people working together towards answering bigger questions. I find this very gratifying and very exciting.

What is the importance of a multi-disciplinary group in this topic? How will it be fruitful?

The topic is inter-disciplinary in its own right. The topic unifies deep earth geodynamics with tectonics, geology and the study of surface processes (which record both the geomorphology and sedimentology at the earth's surface). There are at least five disciplines that play together in this network, it is very difficult to cover those disciplines all by one individual, it is almost impossible to

"It is not so much that the EU wants us to make scientific progresses,

the EU wants to build the next generation of scientists."

do that. So, you need different people to look at different aspects. **What is exciting about SUBITOP is that it always asks of the students and of the PIs to not only cover one topic, but to cover multiple topics, to take multiple perspectives and to tie between fields.** This is something that all the ESRs share, they do this all in individual ways making their own combination of disciplines. If you look at the current practices of the natural sciences, there's an increasing tendency towards interdisciplinary or multidisciplinary work. This is what the future is, and so to train our students in that tradition means that we allow them to develop a thoroughly modern perspective and to prepare them well for a future in a very competitive job market. I think that by focusing on multiple disciplines we do more than that: We ask the student to engage with new learning curves, to stretch themselves and to seek the best in themselves and seek beyond where they are comfortable. This is something that makes you grow and eventually will become a real pleasure to do. This is something that I have personally experienced, I always look for those boundaries and I continuously seek new challenges and different learning curves. It's something that keeps me excited about science.

“We can help society by talking with people outside our strict academic environment and outside our discipline”

What do you expect from the project? What would be the optimum result?

There are two answers to that question, at least two. One is the purely scientific, I hope that by investing so much time and so much money in research into the dynamics of subduction systems that we will gain a better under standing of subduction systems. That is a very broad answer. If you want to be more specific, then it is that link between shallow and deep processes that we need to understand better. What exactly is it in the topography of subduction systems that captures what goes on beneath and how do we quantify it? If we make progress in answering that question, we would have done something useful. The science is as important as the training of young researchers. As I already said, we have a specific approach to training which puts some emphasis on multi-disciplinarity. It is that emphasis, if it is picked up by the students, that should lead to young people who are

competitive, who will get jobs either in the industry or in academia and will maintain connections and links. Who therefore live as a group for a long period of time. **So my dream is that the students of the SUBITOP consortium do disproportionally well in their individual projects but also do disproportionally well as a group** and manage to step into postdoc positions and eventually faculty positions, if they are interested in academia, or land good jobs in industry if that's what they prefer. So, success in the individual and success on the collective, that I think is very important. This is also what the EU actually asks. It is not so much that the EU wants us to make scientific progresses, the EU wants to build the next generation of scientists.

"I would be excited about something using seismological approaches to new problems to monitor processes at the Earth's surface for example."

What are the potential benefits for society?

It's very hard to translate (geo-)science directly to societal benefits. In some cases it is possible, in other cases you have to look for several connections. In the case of understanding subduction systems, your mind may immediately go to natural hazards that are associated with subduction, in the form of earthquakes and for very rapid and destructive erosion for example. Not all projects deal with that in a direct way or even in an indirect way, but all the projects support understanding the subduction systems which can eventually be translated into better predictive understanding of natural hazards. We can also look at resources. Subduction systems are very resource rich, for example metalliferous formations and deposits. Although we don't deal with that directly, actually understanding the workings of subduction systems will allow other people to better understand the formation of these resources and the locations of these resources within subduction systems. Ultimately, though, I think that we can help society by talking with people outside our strict academic environment and outside our discipline. By talking to children in school for example. We can explain to people how the scientific mechanism works and what (un-)certainties are associated with scientific findings. At the moment, that is not very well understood by general the public, and it's not very well translated and appreciated by the media. **By going directly to schools we can explain to the next generation of scientists how science really works, and what it can**

do and especially what it can't do: where the limits are to our understanding, to our capabilities. This is of profound importance if you want to look towards science for solutions and for challenges. It is this general perspective in outreach that I think is one of the key things we can contribute in a direct way to society.

Will there be a consecutive project?

You can't continue to bring a large number of young scientist into a particular field at a very high rate. With TOPOMOD in 4 years we put 15 young scientist into geodynamics, with SUBITOP we do the same. So in less than 10 years, we have put 30 new scientist into a field that contains maybe a total of 200 researchers in Europe. That is saturating the market so to speak. I think it would be unwise to immediately follow up with a future ITN in this particular direction or with the same philosophy. I think that the Topo-Europe community has to look for other avenues, and if I look personally then I can think of several themes that would very much excite me to create an ITN on. They are not necessarily located within the Topo-Europe or the coupled shallow and deep processes domain. I would be exited to do something at the interface of geophysics and geochemistry. I would be excited about something using seismological approaches to new problems to monitor processes at the Earth's surface for example. This is something that my research actually focuses on, and where we have a rapid emergence of a new field. To support that emergence with an ITN would be worthwhile and might be more profitable not only for PIs, but also especially for young scientist who come in. They would come into a field that is not as mature as the one occupied by Topo-Europe at present and the field where SUBITOP operates in.

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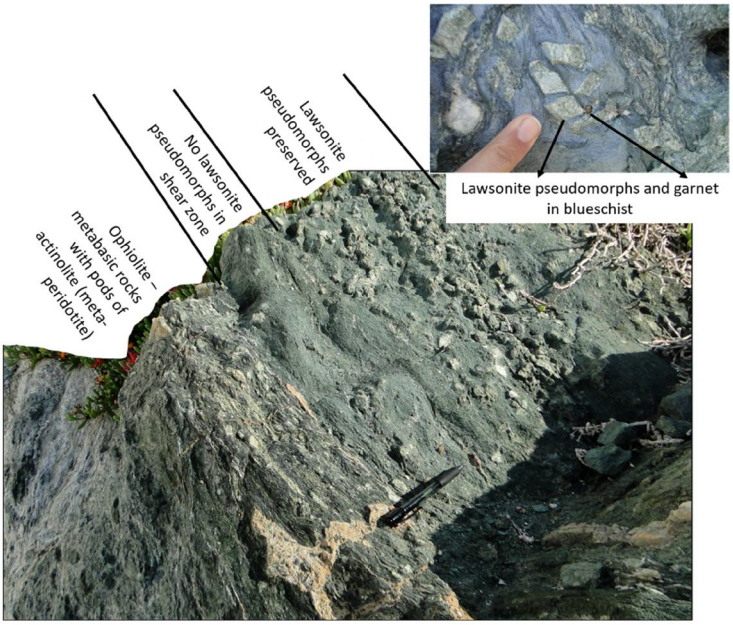
First SUBITOP meeting in Greece, November 2016

Our first SUBITOP short course took us to Greece. The area is not only an active subduction zone, it also has the peculiarity to have a fast retreating trench around which topography is built and destroyed. All those aspects make it a very appropriate location to introduce us to subduction-topography dynamics. These two weeks on the field in the Cyclades and Gulf of Corinth were led by J.P Brun, Frédéric Gueydan, Niels Hovius and Dimitrios Sokoutis. Besides the 14 ESRs, several PIs, industrial partners and school teachers joined the trip making it an inspiring environment to work in.

The trip started with an introduction by Jean-Pierre Brun and Frédéric Gueydan. They caught us up on the last 60 million years or so of Mediterranean tectonics: After the closure of the ancient Tethys ocean in the collision that built the Alps, the African plate started to subduct beneath Eurasia. As this progressed, the Mediterranean subduction zone broke up into individual trenches that have been rolling back, tearing and rotating. The Hellenic trench is currently the most active of these, and is rolling back at ~3cm/yr – a rate which has sped up from <1cm/yr at ~30 Ma ago. The rollback has caused extension in the upper plate on the European side. Extension inherently thins the crust, but in a rolling back system, it seems to also exhume blocks that have been subducted. The Cyclades, thus, contain rocks that have been subducted to high pressures and were then brought back to the surface. Lucky for us, deformation does not affect an entire assemblage equally. Parts of the rocks are overwritten by their journey to the surface, while others still show subduction signatures. The outcrops in Syros add quite a bit of colour to this picture. In addition to the typical ophiolite assemblage (exhumed ocean lithosphere), we find blueschist rocks that give us a glimpse into rocks deep in the subduction zone. These form at high pressure, low temperature conditions and contain glaucophane, which gives them their dark blue colour. In places where the pressure is highest, denser eclogite lenses form, made up of red garnet and green omphacite. All in all, a pleasing rock to look at.

The best clue to this in the Cyclades is a mineral called lawsonite. This mineral forms deep in the subduction zone and is only stable at high pressure. When it is exhumed to the surface where the pressure is low, it breaks down to softer minerals. If it is not sheared on the way up, the new minerals form in the same crystal shape of lawsonite – what is called a pseudomorph. The outcrops in Syros have lawsonite pseudomorphs (unsheared, exhumed) right next to shear zones where the lawsonite pseudomorphs have been stretched away.



Preserved lawsonite pseudomorphs recording subduction and shear zones recording exhumation, Syros. Picture by Manar Alsaif

The presence and state of these features evidences three statements regarding to the rocks history:

- The rocks have been subducted to great depths and pressures
- The rocks have been brought back to the surface – the space for which is created by the rolling back subduction zone
- Deformation is concentrated in some parts of the rock, while others are not sheared

The Cyclades went through a late stage of brittle strike-slip and normal faulting at the surface, and now they are finally at rest as deformation moves westwards. The Cyclades have, thus, given us an preview of the processes currently taking place deep beneath Corinth and the Peloponnese.

The second part of the first SUBITOP field trip was based in Loutraki, at the east coast of the Gulf of Corinth. This region is a world-class example for an extensional system in its early stages. Together with the experience of the late extensional system gained in Syros, it completed a wonderful overview of the rollback of the Hellenic trench and the consecutive phases of extension.

To gain the basics of structural geology, Niels Hovius took the group to the Pissia fault which was last active in 1981 causing a magnitude 6.4 earthquake. On the basis of this textbook fault we learned (or revised) the terminology required to describe the whole fault system in the following days. The Pissia fault is one of numerous north dipping normal faults located in the Gulf's south which perfectly characterise such an extensional system. The array of north dipping faults create several relay ramps transporting sediments to the coast and forming 'alluvial fans'. Surprisingly, we found several alluvial fans the following day high in the Peloponnese mountains. These were created by four generations of normal faults on which the sediments changed from being on the down-going hangingwall to the elevating footwall.

Fellows and PIs looking at the Pissia fault.

The north of the Gulf is also characterised by normal faults and extension. However, in contrast to the south, the faults are south-dipping and the extension rates here are slower. This exhibits an asymmetry for the whole system opening the basin in the Gulf of Corinth. To complete the overview of the area we travelled north to the Gulf of Evia. With it being a minor version of the Gulf of Corinth we could apply our (new) geological knowledge and seek the characteristics of this small extensional system ourselves.

Ancient Delphy, it's possible to identify the Theatre and Apolo's temple.

A large part of our final day we spent as tourists visiting the ancient city of Delphi and an old monastery. It was a pleasant way to finish off this exciting, interesting and inspiring trip. We are looking forward to the next meeting in Edinburgh!

ESR and some PIs, at the Gulf of Corinth

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Upcoming events:

- **NNESMO NERC Modeling Course (Durham, 27-31 March 2017)**

- http://community.dur.ac.uk/nerc.modelling/

- **SUBITOP Short Course 2 - Modelling Tectonics and Topography (3-9 April 2017)**

- http://www.subitop.eu/training/short-courses/

- **Image analysis in geosciences (Tromso, 3-7 April 2017)**

- https://earth.unibas.ch/micro/workshops/TOSpract2017/index.html

- **EGU General Assembly (Vienna, 23-28 April 2017)**

- http://egu2017.eu/

- **Workshops at the Annual Meeting of the EGU (Vienna, 23-28 April 2017)**

- http://egu2017.eu/event_requests/short_courses.html
  (final list published later)

- **CIDER 2017 Summer Program on Subduction Zone Structure and Dynamics (19 June to 29 July, Berkeley)**

- http://www.deep-earth.org/summer17.shtml

- **William Smith Meeting 2017 about Plate Tectonics at 50**

- https://www.geolsoc.org.uk/wsmith17

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