Paleoseismology from Iznik lake sediment: long term seismic cycle on the Middle branch of the North Anatolian Fault

Duration: 20 months, start June 2022 (could be adapted).

Supervision: Pierre Sabatier (EDYTEM, Chambéry) ; Julia De Sigoyer (ISTERRE, Grenoble)

Location: Le Bourget du lac (close to Chambéry), NW Alps, France

Profile: The candidate should have completed a thesis in sedimentary geology and have expertise in sedimentology and geochemistry and if possible, experience with seismic reflection data analysis.

Project: The famous city of Nicaea (now Iznik, Turkey, South Marmara zone) 5 km north of the active Middle branch of the North Anatolian Fault (MNAF), was established on the shore of the Lake Iznik during the Neolithic. On May 20th 325 AD, the city hosted the first council of Christian bishops, which represents the founding of Christian religion, and the beginning of a new world. However, the building in which this first council took place remained unknown until 2014 when Prof. Mustafa Şahin, the archaeologist in charge of this region, discovered a big antic basilica of St Neophytos lying under the water, 50 m from shore of the Lake Iznik (Fig. 1; Şahin, M. and Fairchild, 2018). The basilica has been destroyed and submerged after an unknown catastrophic event, probably an earthquake, as suggested by both the tectonic context and the damages observed on the outstanding archaeological remains of the city (Benjelloun et al., 2020). This site allows to study the interaction between tectonic activity, lake-level variations and the development of humanity.

The MNAF closed by Iznik, belongs to the NAF system, the most active fault system in Europe. The MNAF moves at a rate of 5 mm/yr (Benjelloun et al., 2020; Ozener et al., 2013), four times slower than the northern segment (NNAF). Actually, no seismicity has been recorded on the MNAF segment since the beginning of instrumental period (>150 years) which led Le Pichon et al. (2014) to discuss a possible deactivation of the MNAF. Nevertheless, six historical earthquakes with Mw >7 have struck Iznik [5] in the past 2500 years as revealed by historical data and by our recent seismotectonic and archaeoseismologic studies (Özalp et al., 2013; Benjelloun et al., 2018) although none of them can clearly be associated to the destruction of the basilica. These earthquakes have broken several segments of the MNAF. A long recurrence time has been inferred between large earthquakes on the MNAF (>500 years) (Benjelloun et al., 2020). As no large earthquake was recorded in the last centuries (Özalp et al., 2013; Benjelloun et al., 2018), the likelihood of a near-future and important earthquake in this area has tremendously increased. Besides, super-shear earthquakes breaking very linear segment of fault were previously described along the NAF during the Izmit and Düzce earthquakes in 1999 (Michel and Avouc 2002). Such a type of earthquakes is very damaging and can triggered tsunami as observed during the Palu earthquake 2018 Indonesia (Socquet et al., 2019)
To improve the seismic risk assessment in the region of Iznik, which depends both on the seismic hazard and on the vulnerability of the site and buildings, a good knowledge of the fault mapping and of the historical earthquakes catalogues is required. As recurrence time of earthquake is long on the MNAF, we need to go much further back in the past to understand the seismic behaviour on the MNAF and its impact on human culture.

Key questions remain unanswered:

What might be the return period of large earthquakes on the Middle branch of the North Anatolian Fault? Could a large earthquake and related tsunami destroy the Nicea basilica? How have such past events affected human communities in this Turkish region?

The answers to these questions are the general objectives of the BAZILINIK-SECRETS program (PI: J. De Sigoyer) which has received funding from the Agence Nationale de Recherche (ANR) for the 2020-2024 period. Important data have already been acquired during previous campaigns whose objectives were to identify in sedimentary archive records strong earthquakes in Iznik lake (Gastineau et al., 2021) as well as on archaeological building (Benjeloun et al., 2018), geomorphological analyses (Benjeloun et al., 2021), fault trench and lake coastal sedimentary survey. In the framework of this project during the Renaldo Gastineau PhD a linear fault was discovered in the Iznik Lake thanks to bathymetric and seismic survey. Short cores of sediments sampled on both part of the Iznik fault revealed that it was broken by a last earthquake in 1065 CE (Gastineau et al., 2021). An other earthquake is observed on these cores but they are too short to characterize it, longer cores are required. The 1065 earthquake has triggered several other turbidites in the lake with important lateral variation in the event deposits as revealed by the study of 14 cores laterally spread in the lake (Gastineau et al., under review). Furthemore about 15 earthquakes were recorded in the Lake Iznik since 2500 years. Only some of them have broken the Iznik fault. It is important to sort which earthquake has broken which segment of fault along the NAF system.
In the November 2021, a coring mission with Uwitec coring platform from CNRS allowed to sample 4 long sediment cores with a total more than 70m of sediment (Figure 1) to reconstruct long term earthquake chronicle and seismic cycle along the Middle branch of the North Anatolian Fault.

The objective of this 20-month postdoctoral project is therefore 1/ the identification in seismic data of mass wasted deposits and vertical as well as lateral offsets all along on Iznik fault, 2/ to document in sedimentary records the catalogue of earthquakes, over the Holocene and Late Glacial in lake Iznik, trying to know better their location and magnitude and 3/ to reconstruct long term seismic cycle on the Middle branch of the North Anatolian Fault.

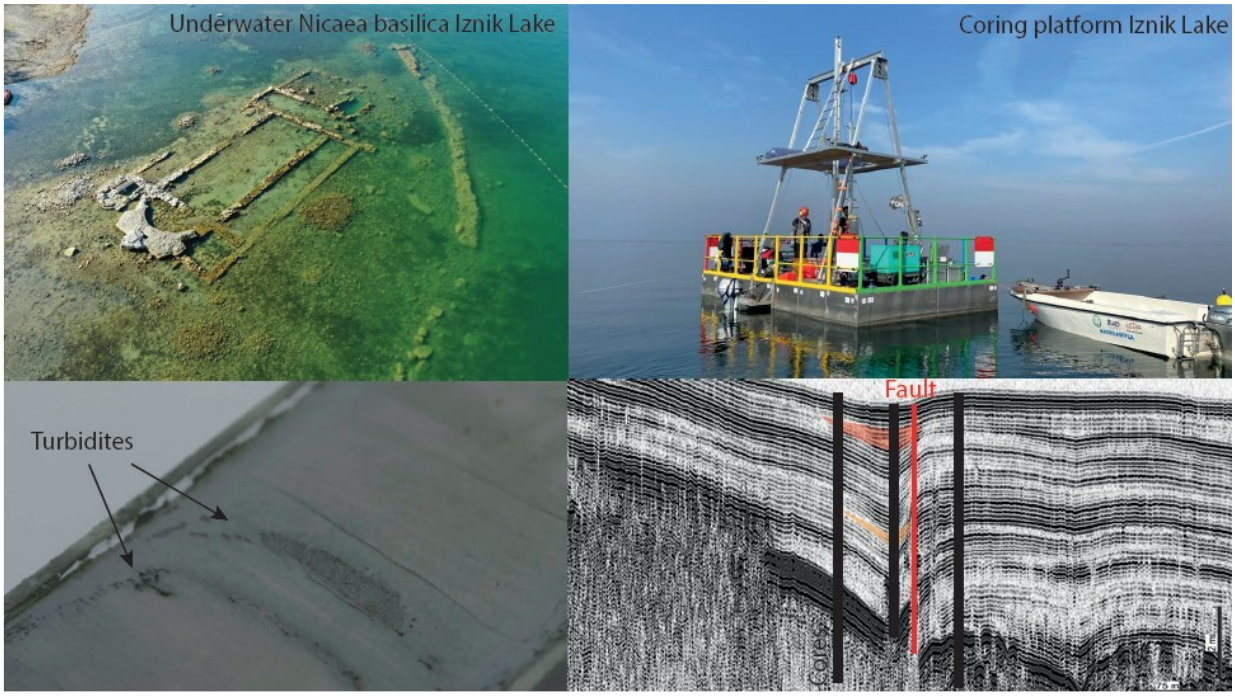

Figure 1: Underwater Nicea basilica on the eastern coast of Iznik lake; Coring platform on Iznik lake (November 2021); Small turbidites related to historical earthquakes in Iznik lake; Seismic profile along the Iznik fault (Gastineau et al., 2021) with location of 3 coring sites across the fault.

Methodology:

In order to recognize and reconstruct these event chronicles, a multiproxy approach will be applied by combining 1) seismic and bathymetric interpretations (Gastineau et al., 2021), 2) sedimentary with granulometry, mineralogy and thin sections (Sabatier et al., 2010; Biguenet et al., 2021), 3) mineral and organic geochemical at the core and thin-slice scales (SEM-EDX) (Rapuc et al., 2018; 2021; Gastineau et al., 2021) and 4) age modelling with short-period radioelement data (Bruel and Sabatier 2020), radiocarbon (Sabatier et al., 2010).

Application: Send a detailed CV and motivation letter **before March 13** to the 2 following address:
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