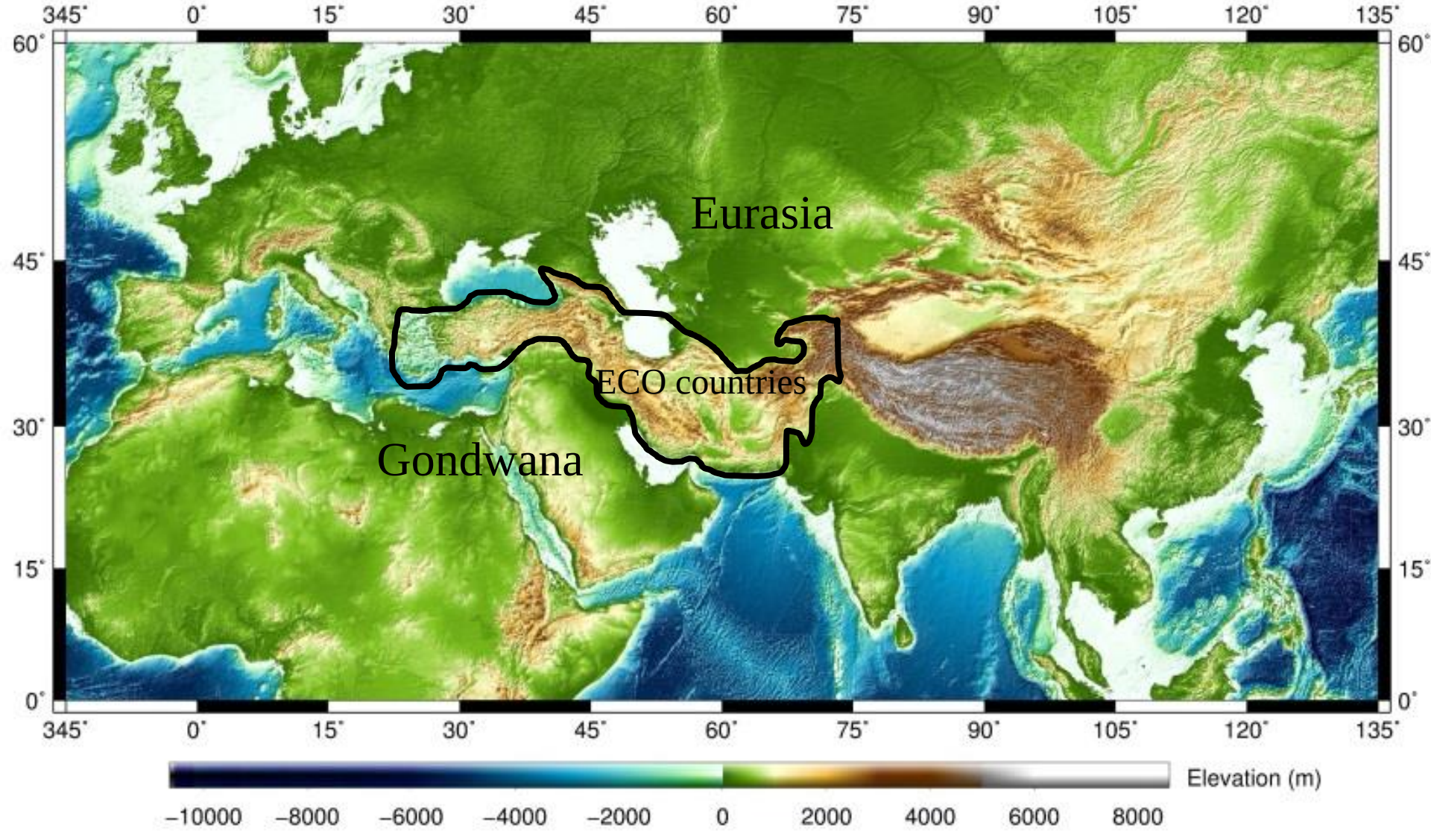
Spiral Tectonic

Represented by
the University of Tabriz, I.R. Iran

March 2022

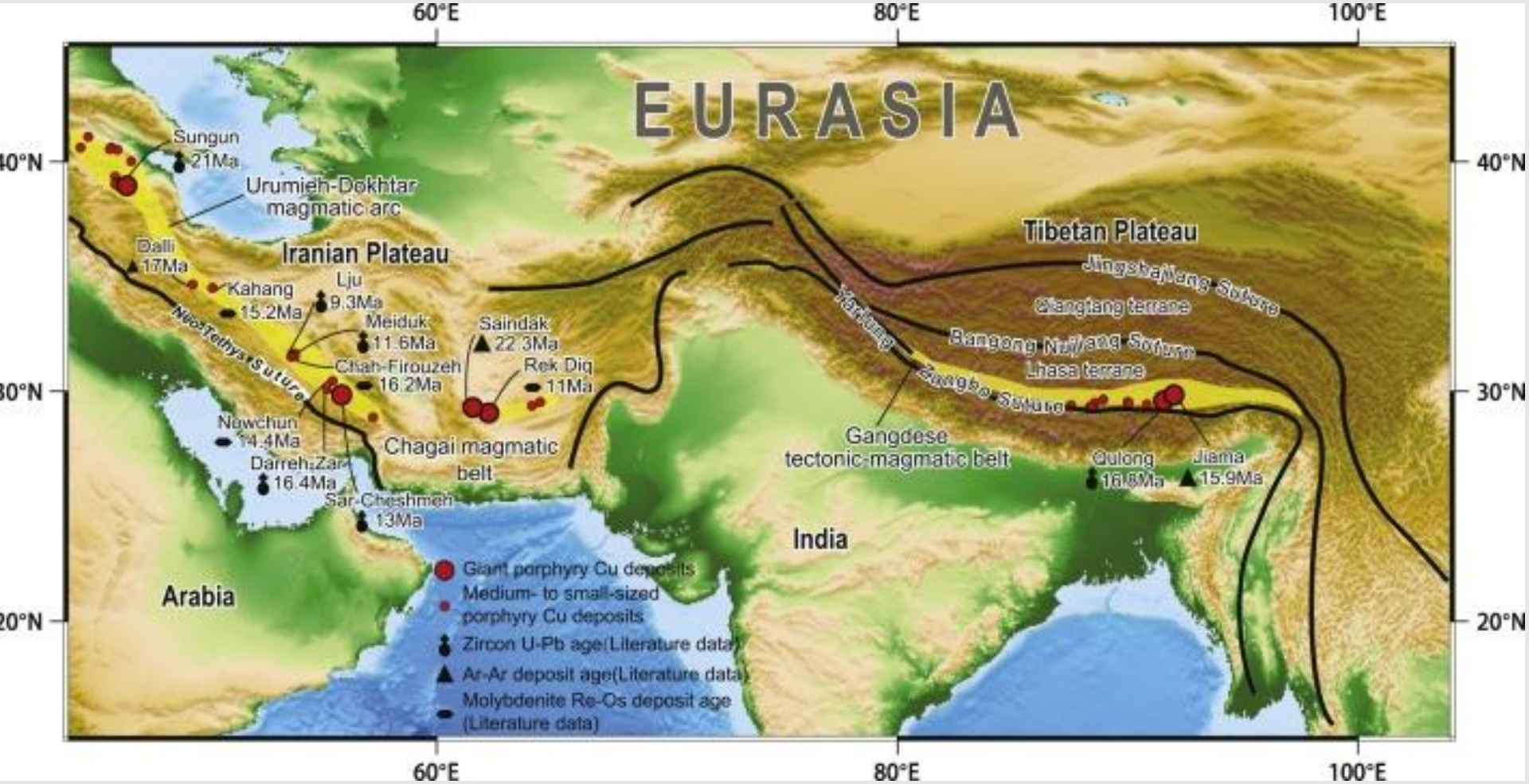
On October 17, 2016 at 6th ECO Minerals Experts Group Meeting convened in Sungun Mine Complex in Tabriz, the spiral tectonic project was proposed by Dr. Elyaszadeh and it was approved in that meeting.

The main objective of this project is providing **Spiroclast map of the ECO member countries** which is located in **tethyan orogenic belt**.



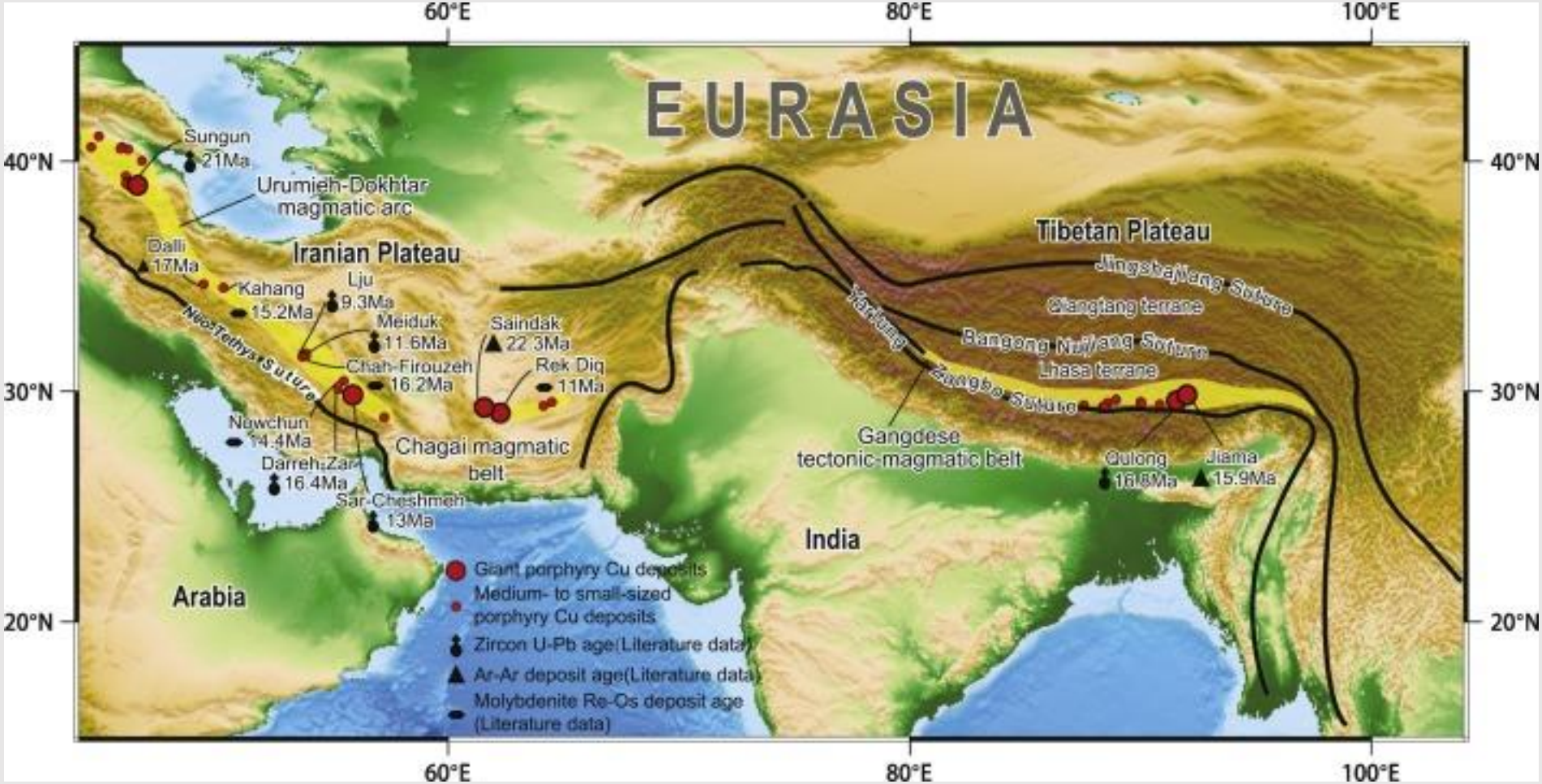
Tethyan Orogenic Belt

- The **Tethyan orogenic belt** or **Alpine-Himalayan orogenic belt**, is a **seismic** and **orogenic belt,**
- It includes an array of **mountain ranges** extending for more than **15,000 km** along the **southern margin of Eurasia**,

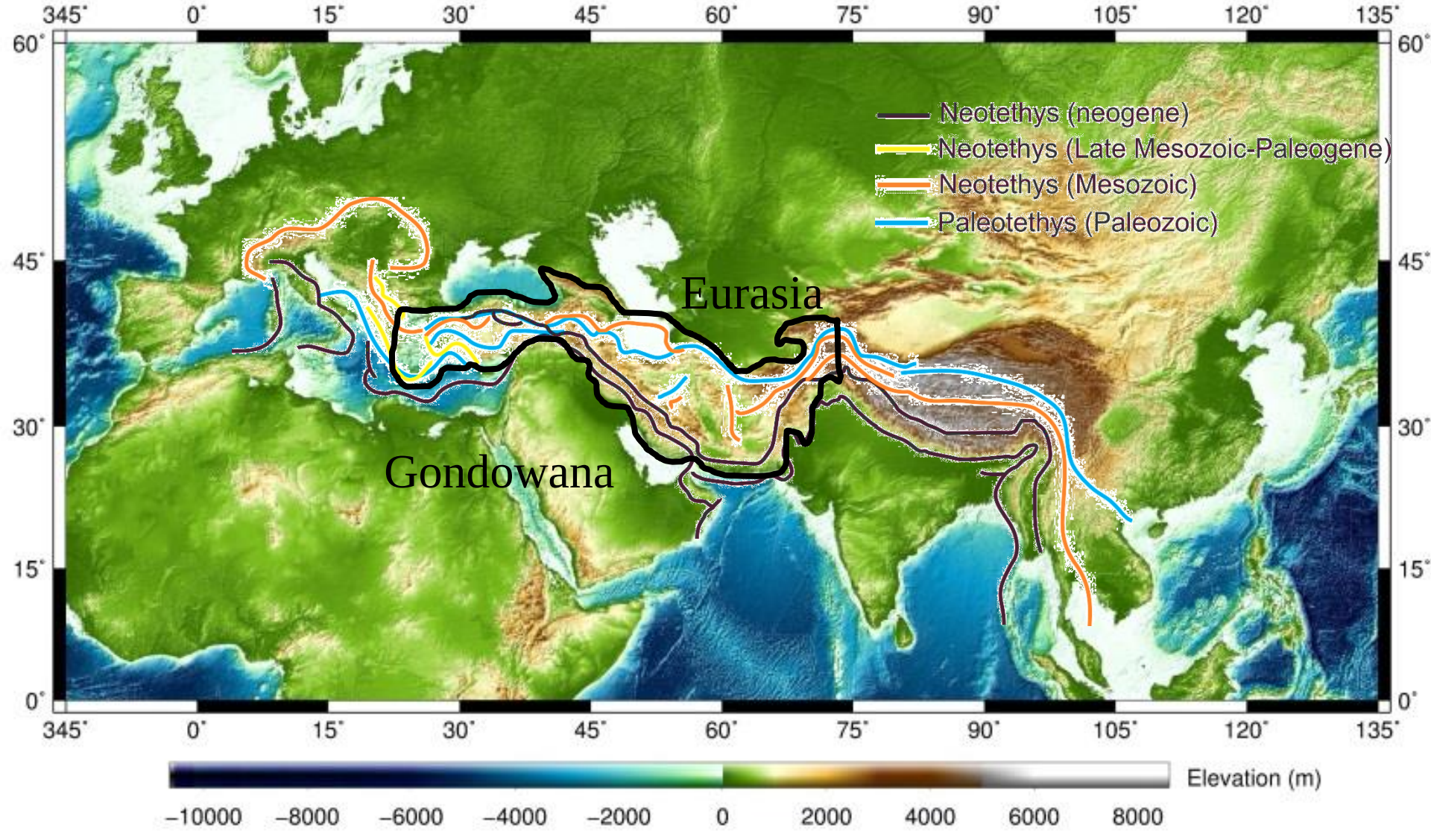


Tethyan Orogenic Belt

- It is composed of a **mosaic of microplates** that **move and deform independently** from the **overall plate convergence**.
- **Recent studies** indicates that **small-scale mantle convections** were developed under these **microplates** that control the **deformation of these microplates**.



- Similar to **shear zones**, that develops between tow **rigid rock unites**, the **Tethyan orogenic belt** also were developed between **two Eurasia and Gondwana rigid plates**.
- So some scientists use the word **mobile belt** for this **orogenic belt**.



Background and Rationale of the Project

- The region has been through many hazards caused by devastating earthquakes (as in 1999 in the ECO countries including Afghanistan, Turkey and Iran).
- Turkey is criss-crossed by fault lines; small quakes are a near-daily experience.
- Iran, as ever, experiences nearly 200 soil oscillations per annum.
- Pakistan, having five seismic zones, suffered from 7.6 magnitude earthquake which resulted in over 70,000 human lives lost.
- Other countries of ECO like Uzbekistan, Kyrgyz Republic, Azerbaijan, and Turkmenistan likewise experience frequent soil oscillations as they are on Eurasian plate, which borders with Gondwana.
- Urgency of reliable geological modeling in earthquake prediction.

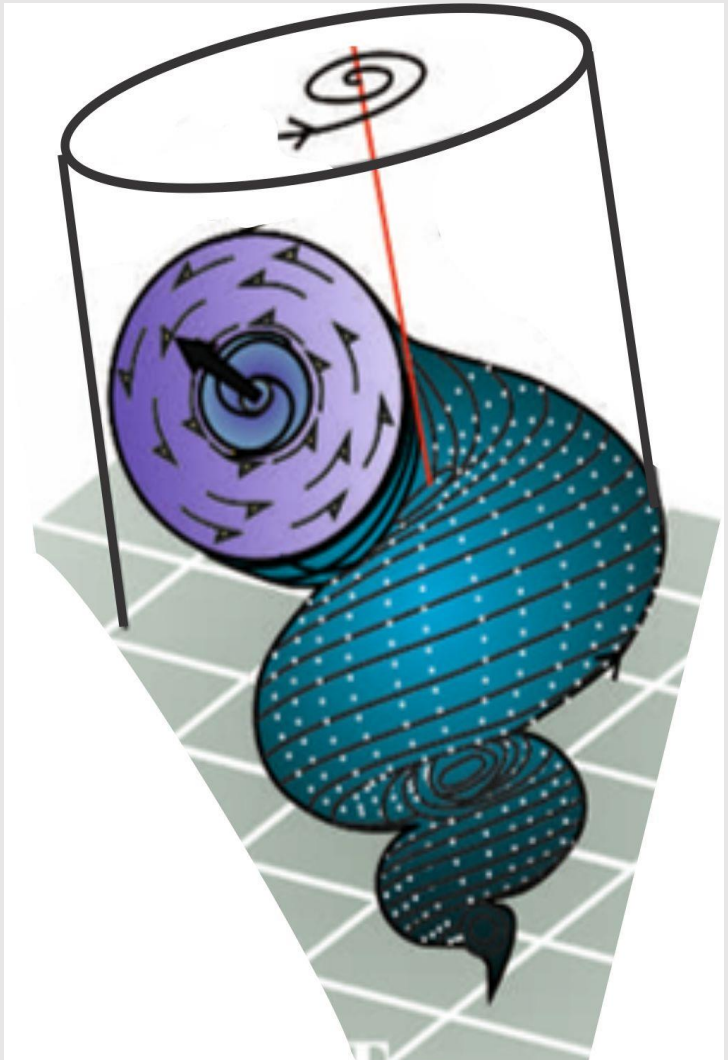
Background and Rationale of the Project

- The **first step** in earthquake prediction: the **identification of active faults in the area.**
- Activity of a fault causes the **displacement of adjacent blocks** and the **occurrence of seismicity in the adjacent areas**.
- **Examining past earthquakes** can help to predict the **occurrence of earthquakes in neighboring areas.**
- **The key question to be addressed is which areas can be the most affected by fault activities?**

Which areas can be the most affected by fault activities?

Spiral Tectonic Model

- Developed new model named as "**spiral tectonic model**" can answer this question.



- In the **tethyan orogenic belts**, **the small scale mantel convection** were developed that they **flow in both horizontal and vertical directions.**

- In a **three-dimensional** state, these flow directions have a **spiral pattern**.

- So we named this as:

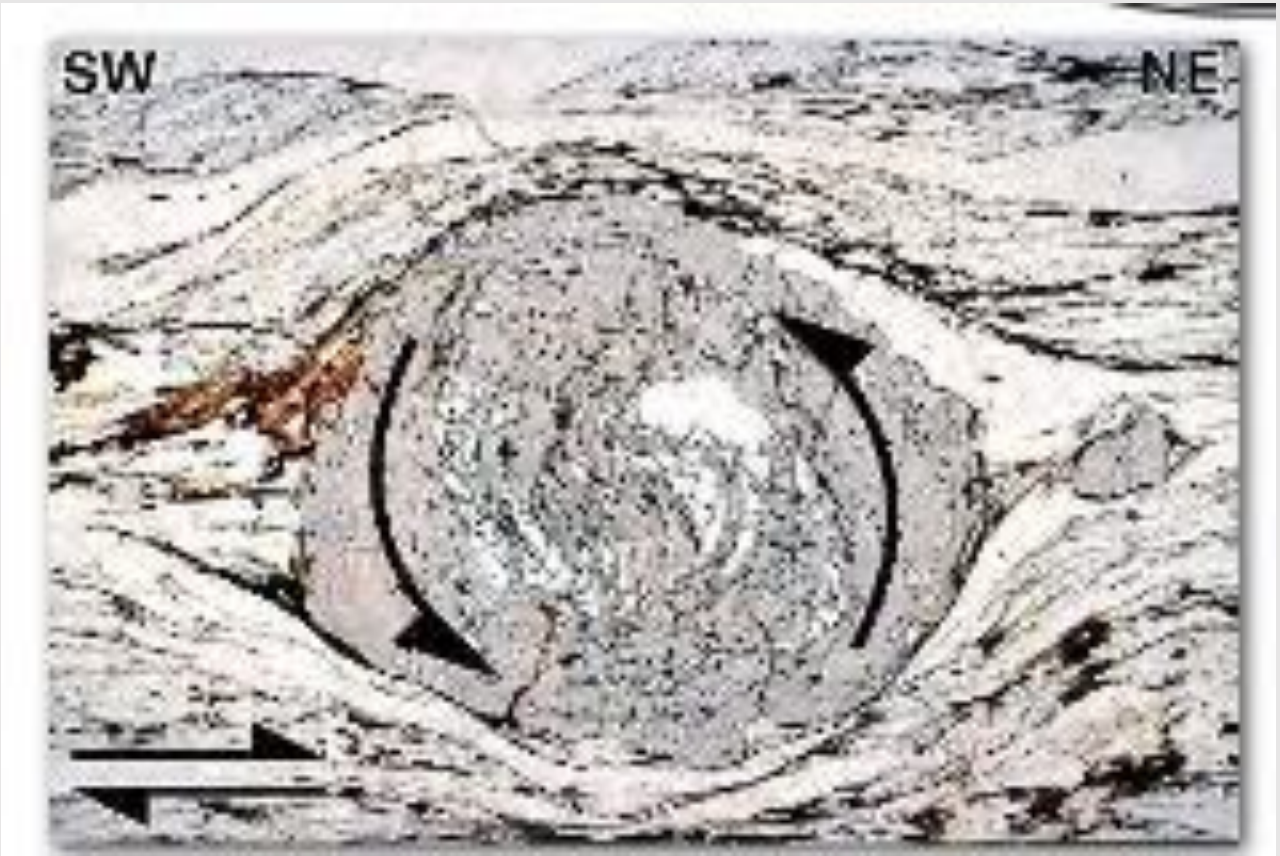
Spiral Tectonic

- In **orogenic belts**, **the microplates over the small scale mantle convection follow the same spiral pattern.**
- **These microplates in orogenic belts are similar to porphyroclasts in shear zones**.

So we named this area as:

Spiroclast

(**Spir**al + **O**rogenic + porphyro**clast**).



Importance of Spiroclast Map

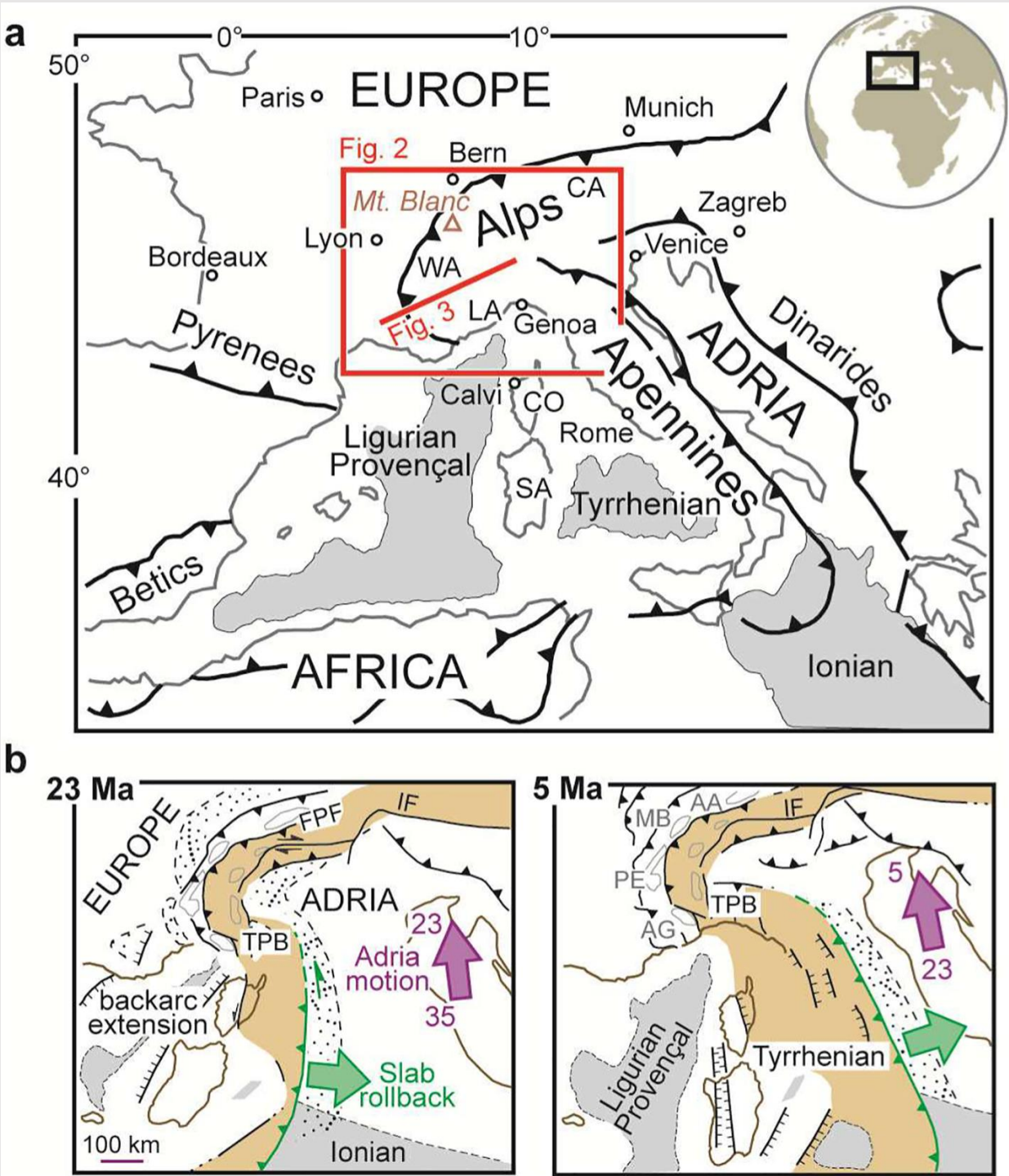
- **Preparation of spiroclast map of mobile belt between Eurasia and Gondwana is essential.**
- **Providing the spiroclast maps is essential in geological investigation.**
- **It expand our understanding about the mechanism of deformation in orogenic belts**
- **It can open a new way in seismotectonic research and especially in earthquake prediction.**
- In this project the **spiroclast maps of ECO countries (Afghanistan, Azerbaijan, Iran, Kazakhstan, Kyrgyz Republic, Pakistan, Tajikistan, Turkey, Turkmenistan, and Uzbekistan)** will be provided.

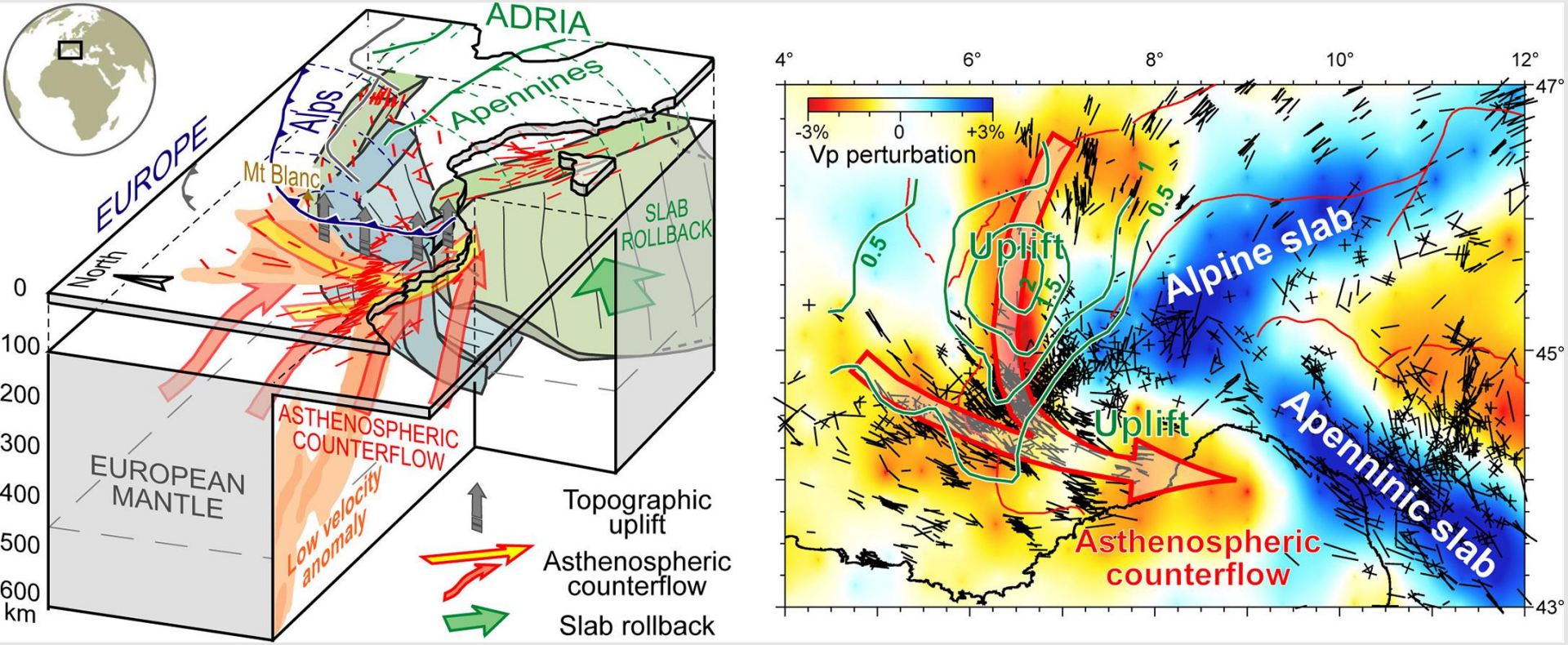
Other Studies:

- **Both counterclockwise** and **asthenospheric upwelling flow** were developed in the **western Alpine region**, at the **boundary** between the **Alpine and Apenninic slabs** (Salimbeni et al., 2018).

- **Tectonic sketch map of the western Mediterranean**, and location of other area (in red; CA, Central Alps; CO, Corsica; LA, Ligurian Alps; SA, Sardinia; WA, Western Alps (after Malusà et al., 2015).

Brown areas mark the **metamorphic Alpine wedge** and the **Apenninic accretionary wedge**; purple arrows indicate Adria trajectories relative to Europe.

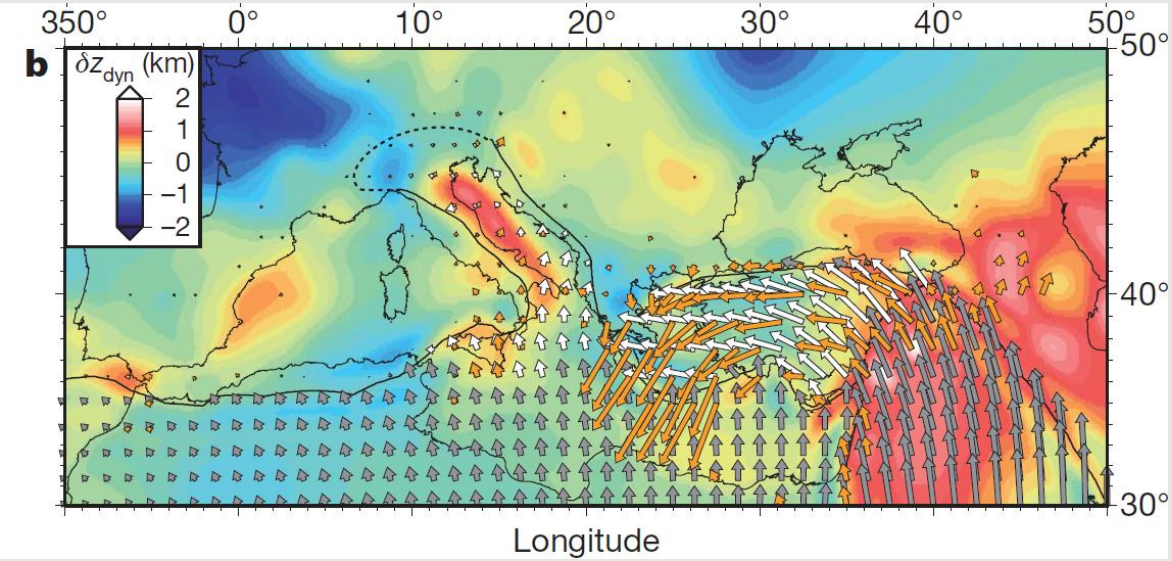




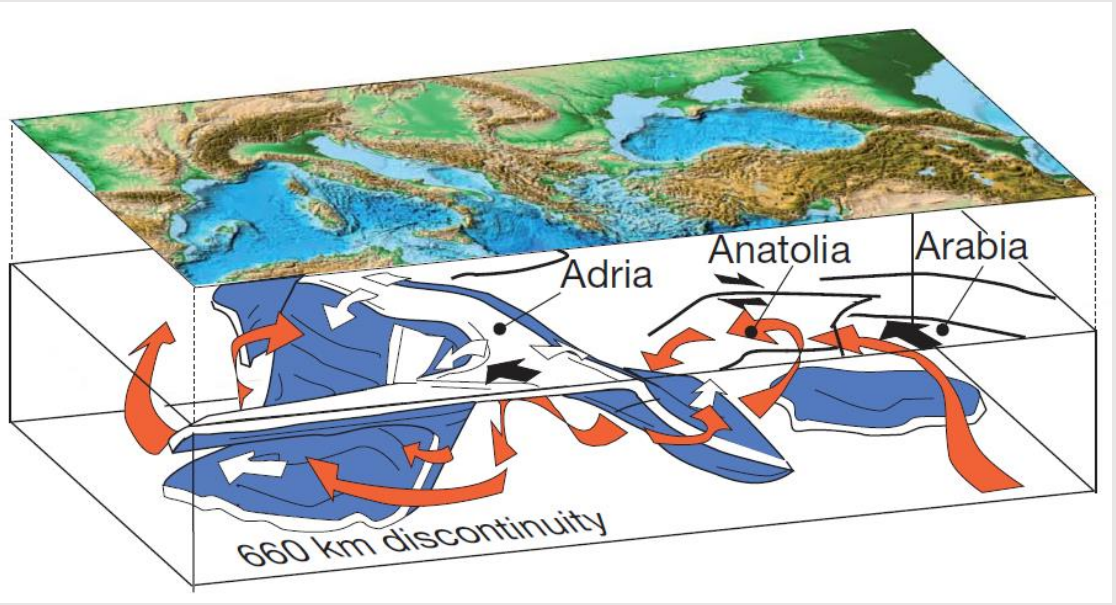
3D model showing the relationships between slab structure, active mantle flow and topographic uplift in the Western and Ligurian Alps regions.

- The **temperature increase due to asthenospheric upwelling**, mirrored by a **low velocity anomaly** in the European mantle (detected by P wave tomography), may have **favored the topographic uplift from the Mt Blanc to the Ligurian coast (**after Zhao et al. 2016a).

- **Similar mantle flow** were determined in the **Mediterranean** region (Faccenna and Becker, 2009, ***Nature***).



Surface velocities, **Flow** (white vectors) generated by **density anomalies** only and **Geodetic velocities** (orange vectors).

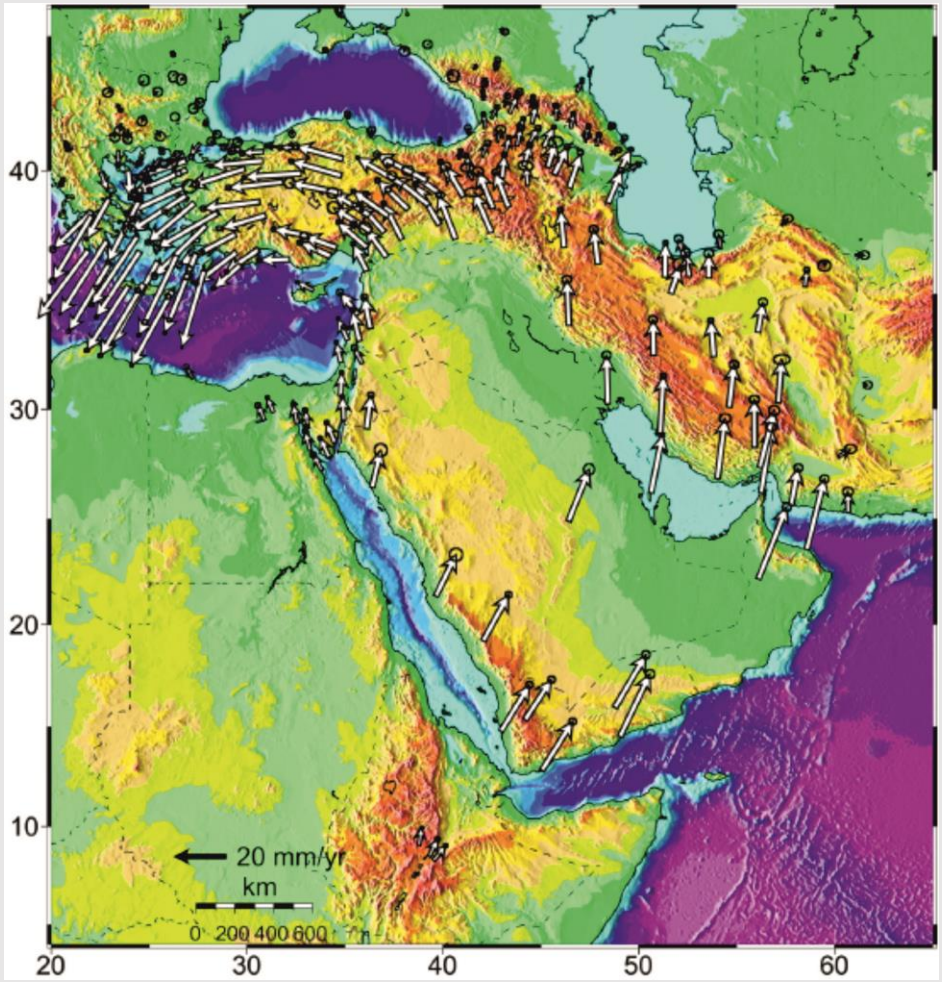


- **Flow produced by density anomalies within the mantle stresses the lithospheric plates and produces both horizontal and vertical motions.**

illustrating the architecture of the subduction zones and the related pattern of mantle convection in the Mediterranean region (Faccenna and Becker, 2009, ***Nature***)

Spiroclast map

- **Previous investigation** of **seismic anisotropy** indicates the **presence** of a **simple mantle flow regime beneath** the **Turkish-Anatolian Plateau and Arabian Plate**.



Reilinger et al., 2006

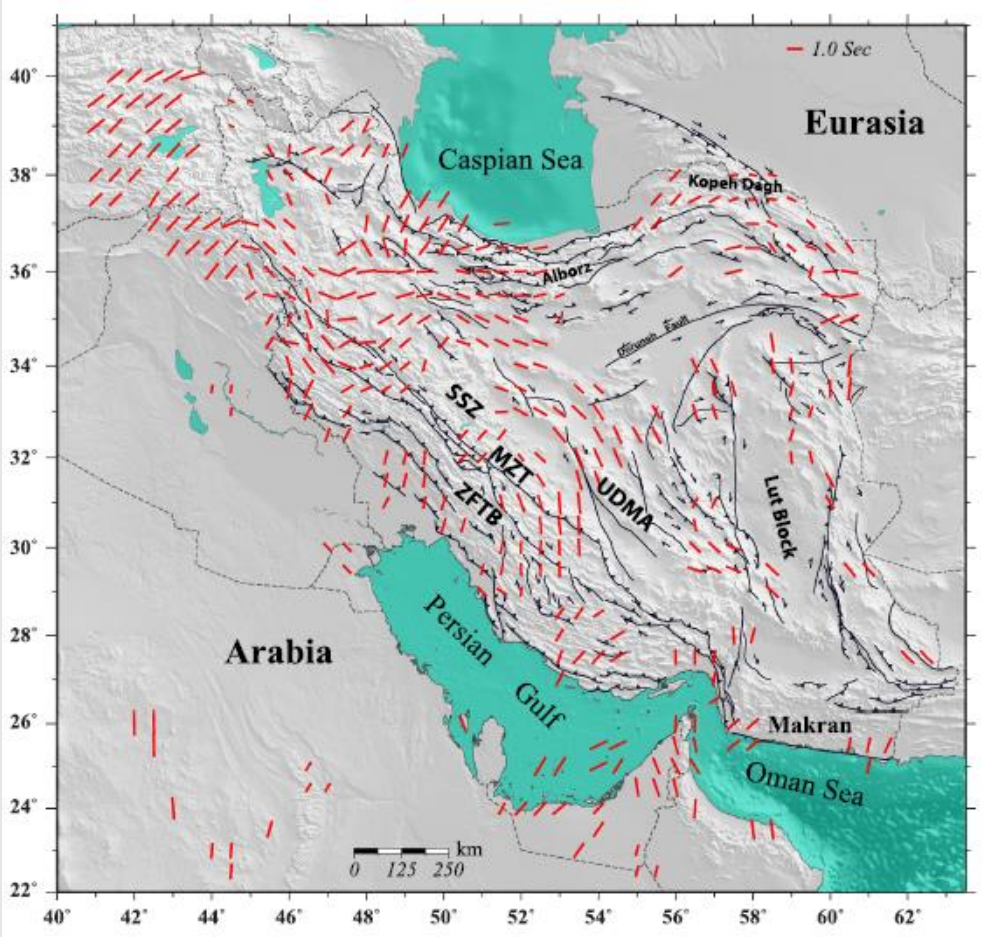
- the correlation between the **pattern of seismic anisotropy**, **plate motion using GPS velocities,** and **surface strain fields** reveals:

- A **complex pattern of seismic anisotropy** that implies a similarly **complex mantle flow field** (Kaviani et al., 2021).

- The **pattern of seismic anisotropy suggests** that the **regional simple mantle flow beneath** the **Arabian Platform** and **eastern Turkey** deflects as a **circular flow** around the thick **Zagros lithosphere**.

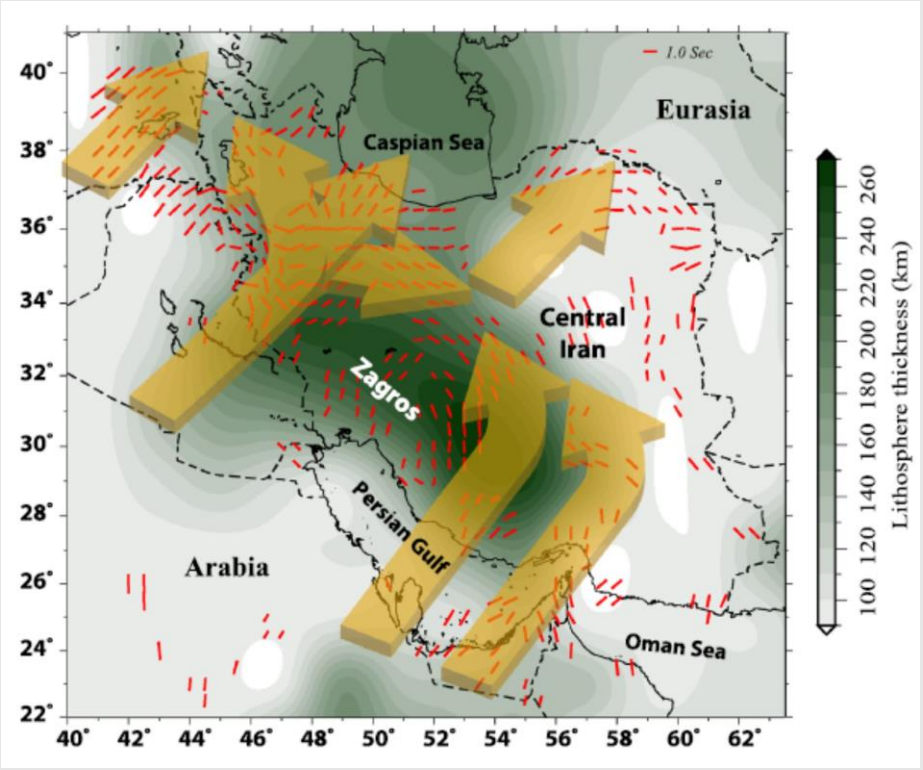
- **it shows small scale mantle convection was developed in this area.**

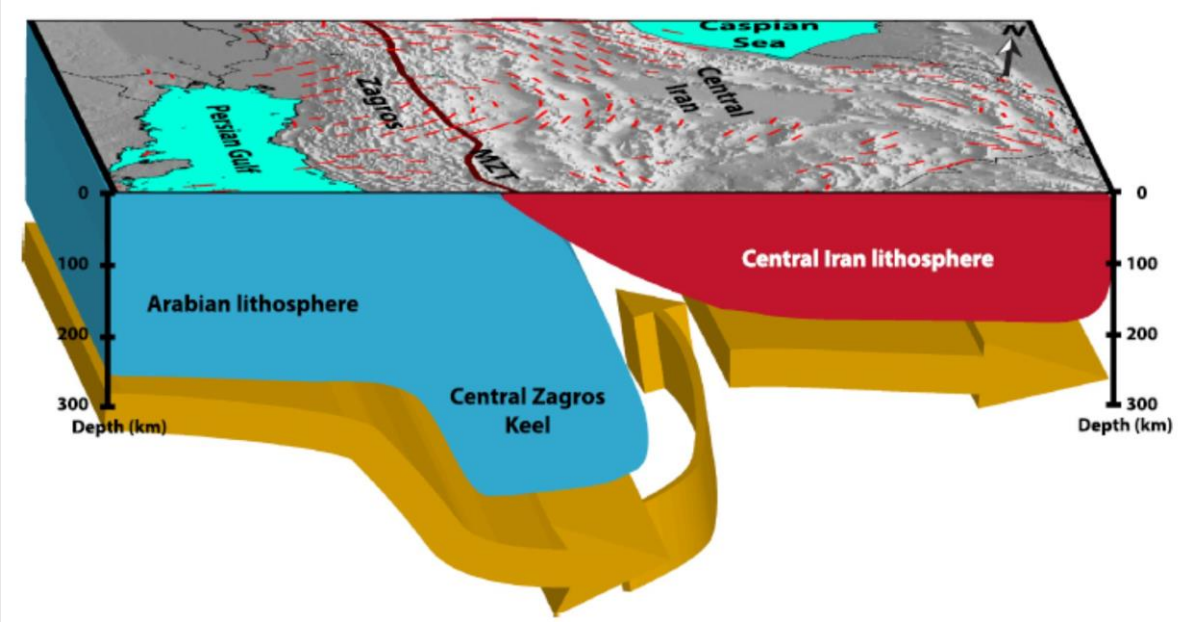
- **So the aim this project is to identify these area and provide a geological map for this areas which we call spiroclast map.**



Interpolated anisotropy field at a depth of 150 km as calculated by averaging the directions at individual stations (Kaviani et al., 2021, ***Nature***).

Schematic illustration of the model showing the possible **circular mantle flow around the Zagros keel.**
(A) a map view.





(B) a 3-D view of the proposed circular **mantle flow** (Kaviani et al., 2021, ***Nature***).

Spiroclast map

The project team from the University of Tabriz of the I.R. Iran under supervision of **Dr. Elyaszadeh** will focus on the ECO region-specific objectives:

- Preparation of the reviewed and updated **Seismotectonic maps** of the ten ECO countries, including the **Afghanistan**, **Azerbaijan**, **Iran**, **Kazakhstan**, **Kyrgyzstan**, **Pakistan, Tajikistan, Turkey, Turkmenistan, and Uzbekistan**.

- **Mapping the updated velocity field**, **stress direction and rotated blocks** of the **ECO countries** in the **mobile belt between Eurasia and Gondwana**.

- Providing **Spiroclast maps** of the **ten ECO countries.**

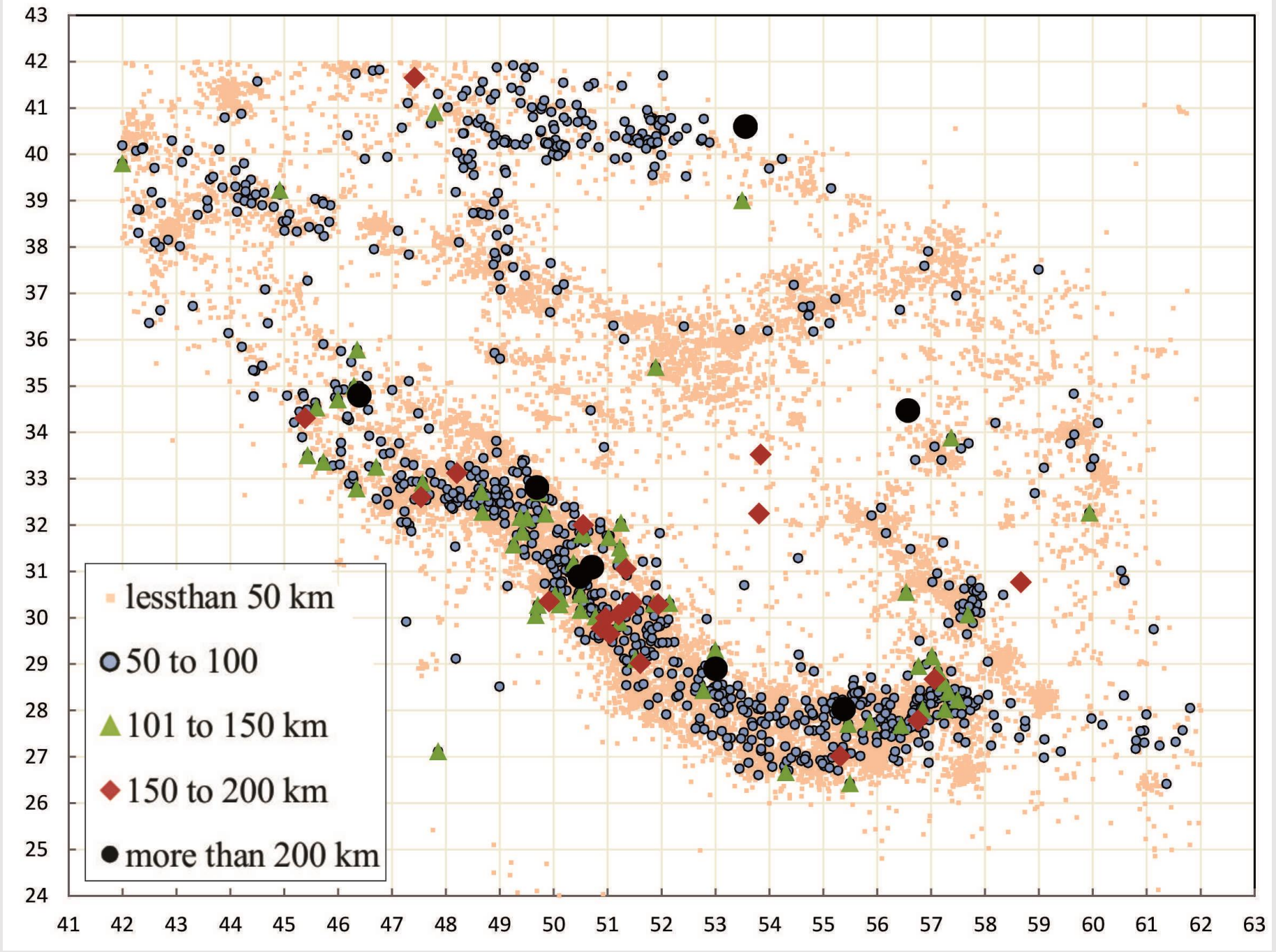
Spiroclast map

Data

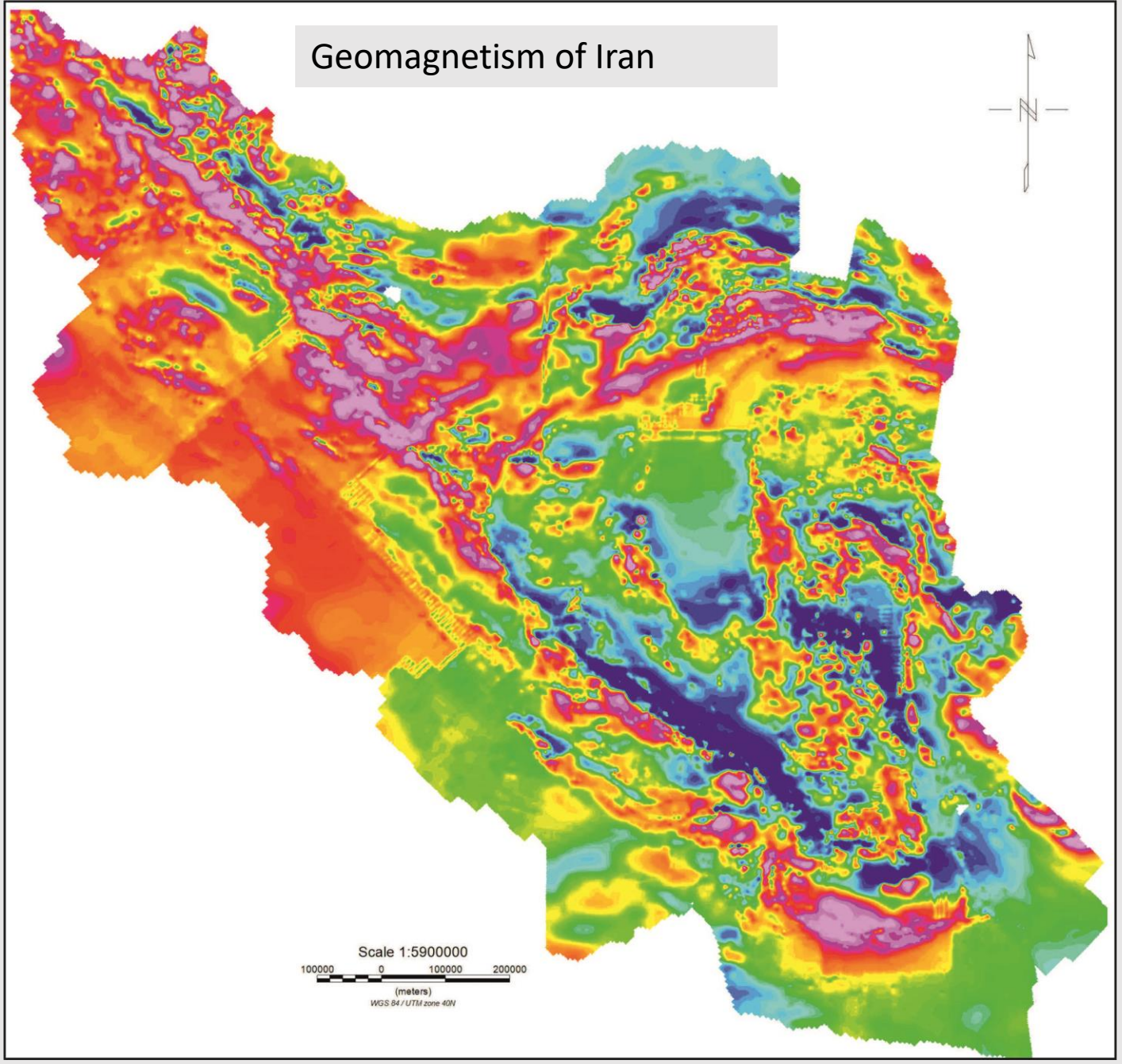
In order to provide a **spiroclast map of ECO region in this project:**

We used all the data from:

- **Geological map**
- **Geomagnetic map**
- **GPS velocity field map**
- **Tectonic map**
- **Stress direction map**
- **Block rotation map**
- **Seismic hazard maps and other geological data-set** (e.g. reports and articles) **in mobile belt between Eurasia** and **Gondwana**

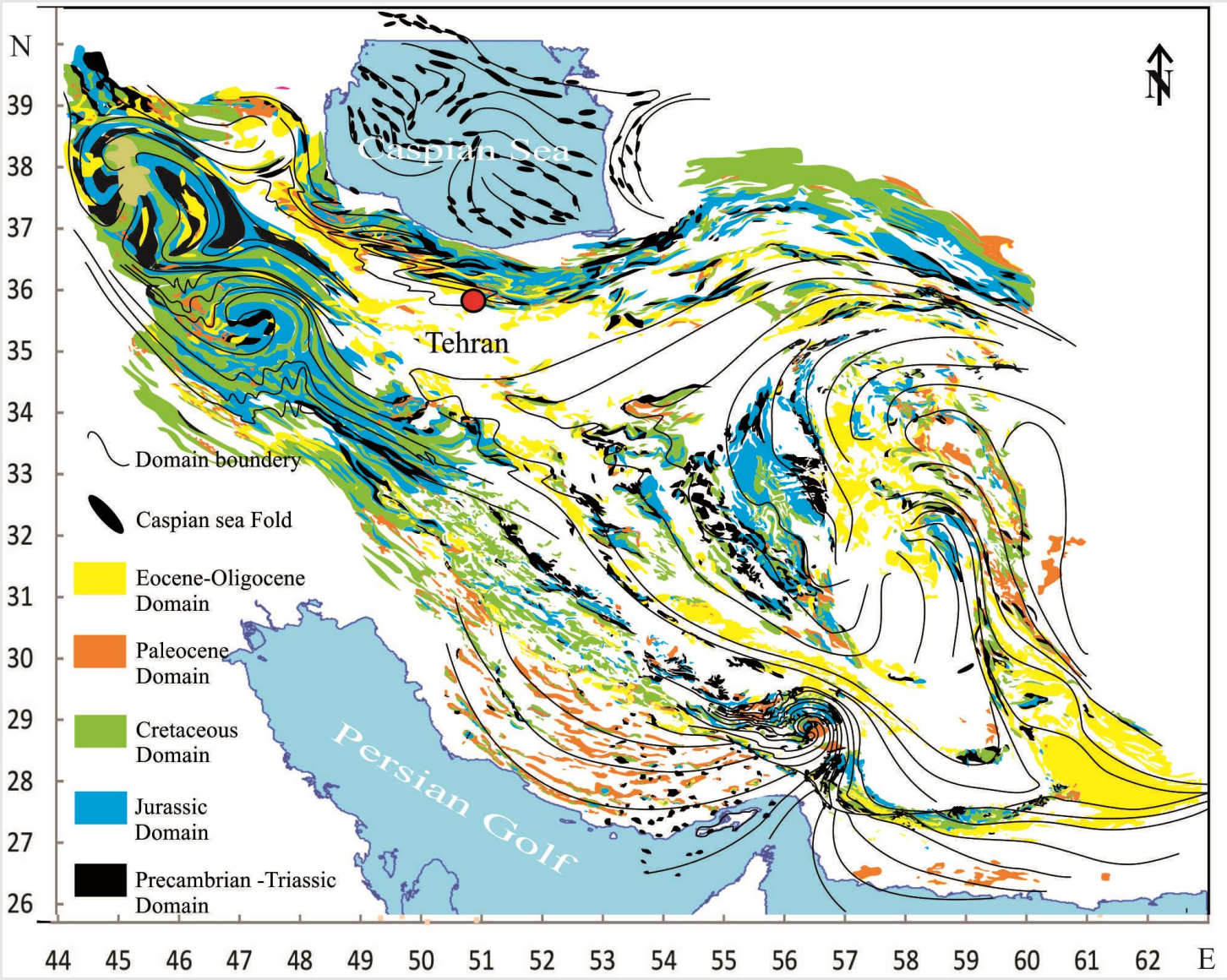


earthquake depth map



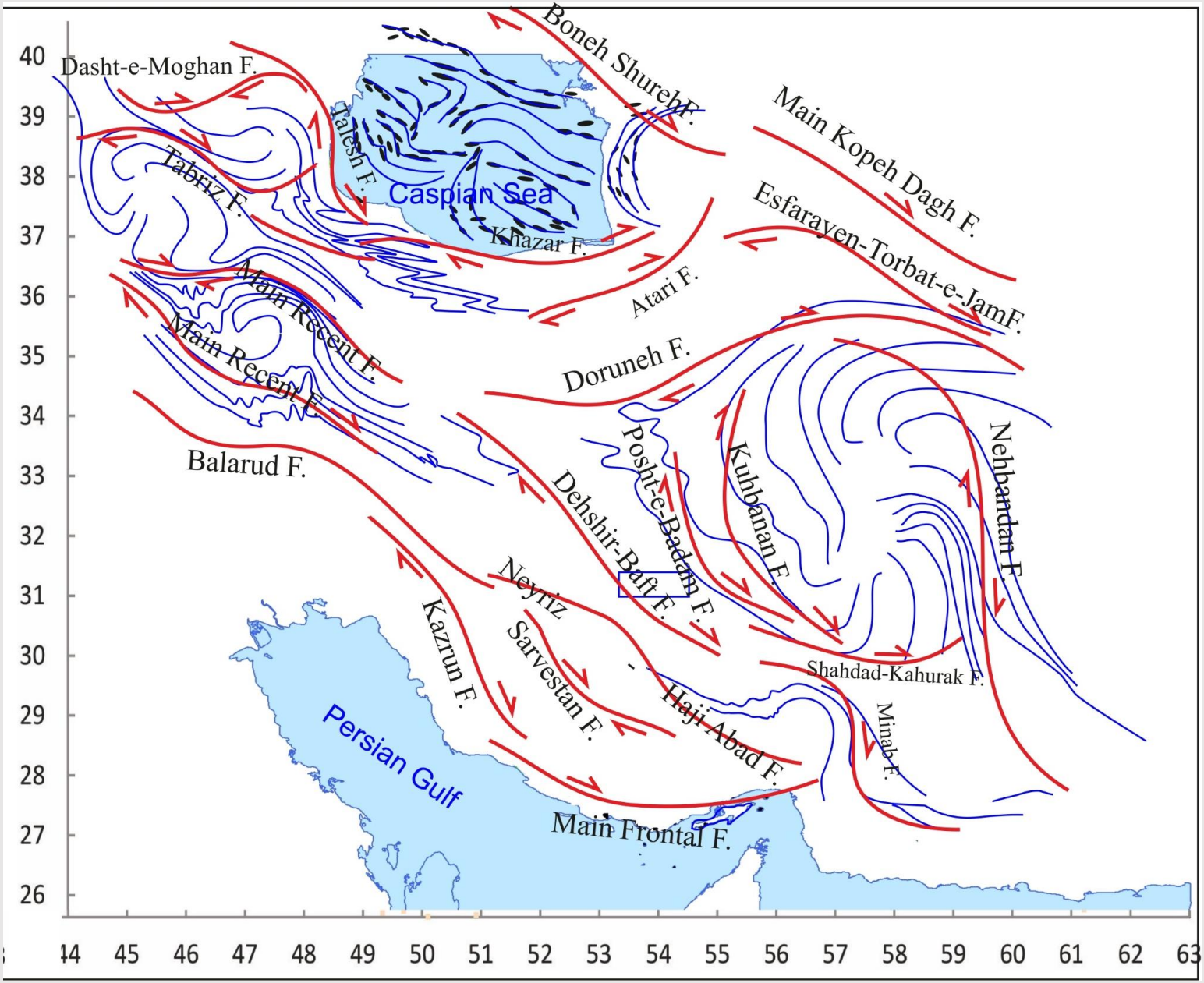
Geomagnetic map

- The **structural maps** are used to **reconstruct the domain boundary line**.
- the rocks from **Precambrian to Oligocene ages were divided** into **five main domains,**
- **The boundries of domains were provided,**
- **Reconstructed domain boundary lines** will be used to find **the Spiroclast centers.**

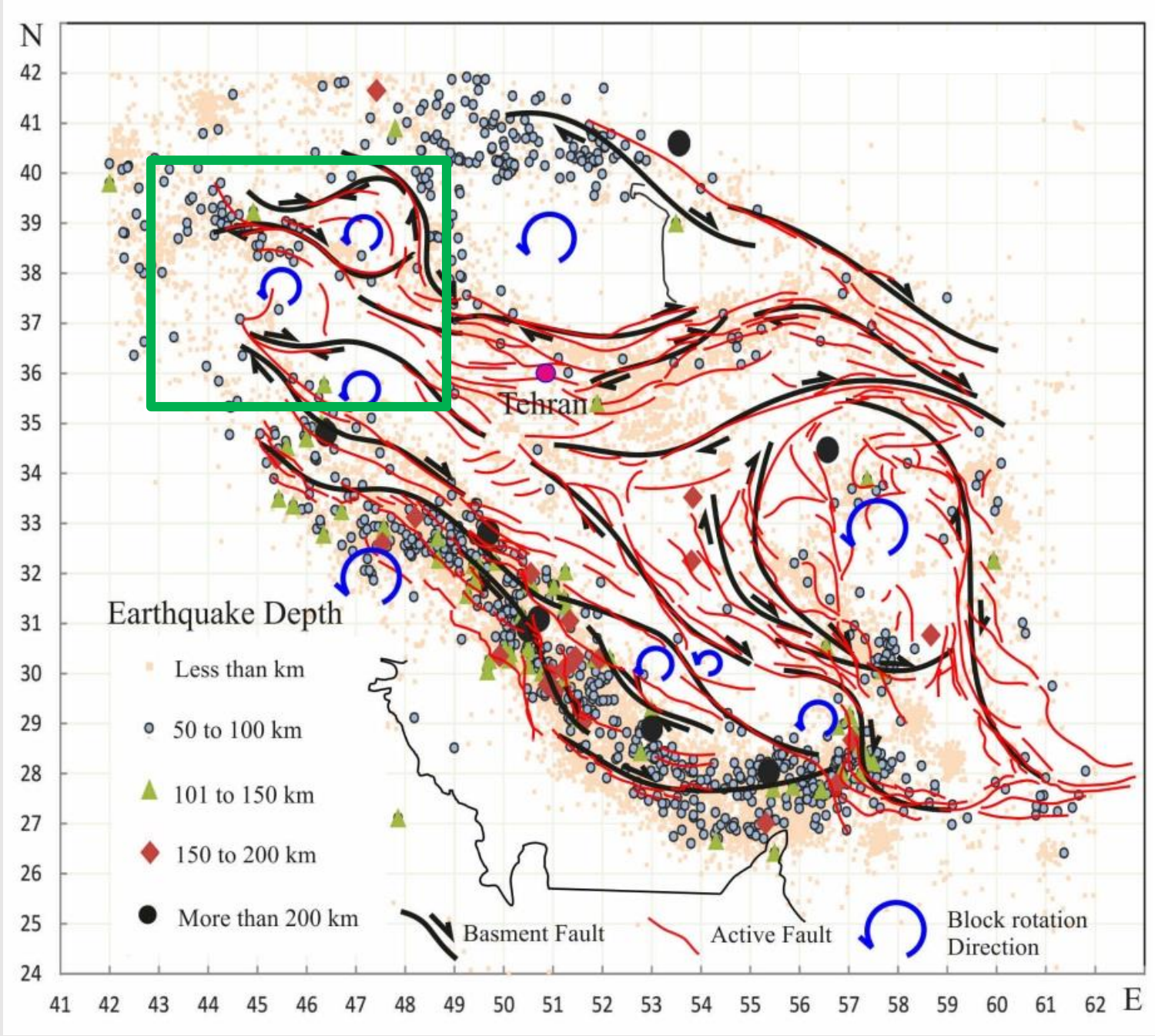


Domain boundaries of geological maps

Fault map



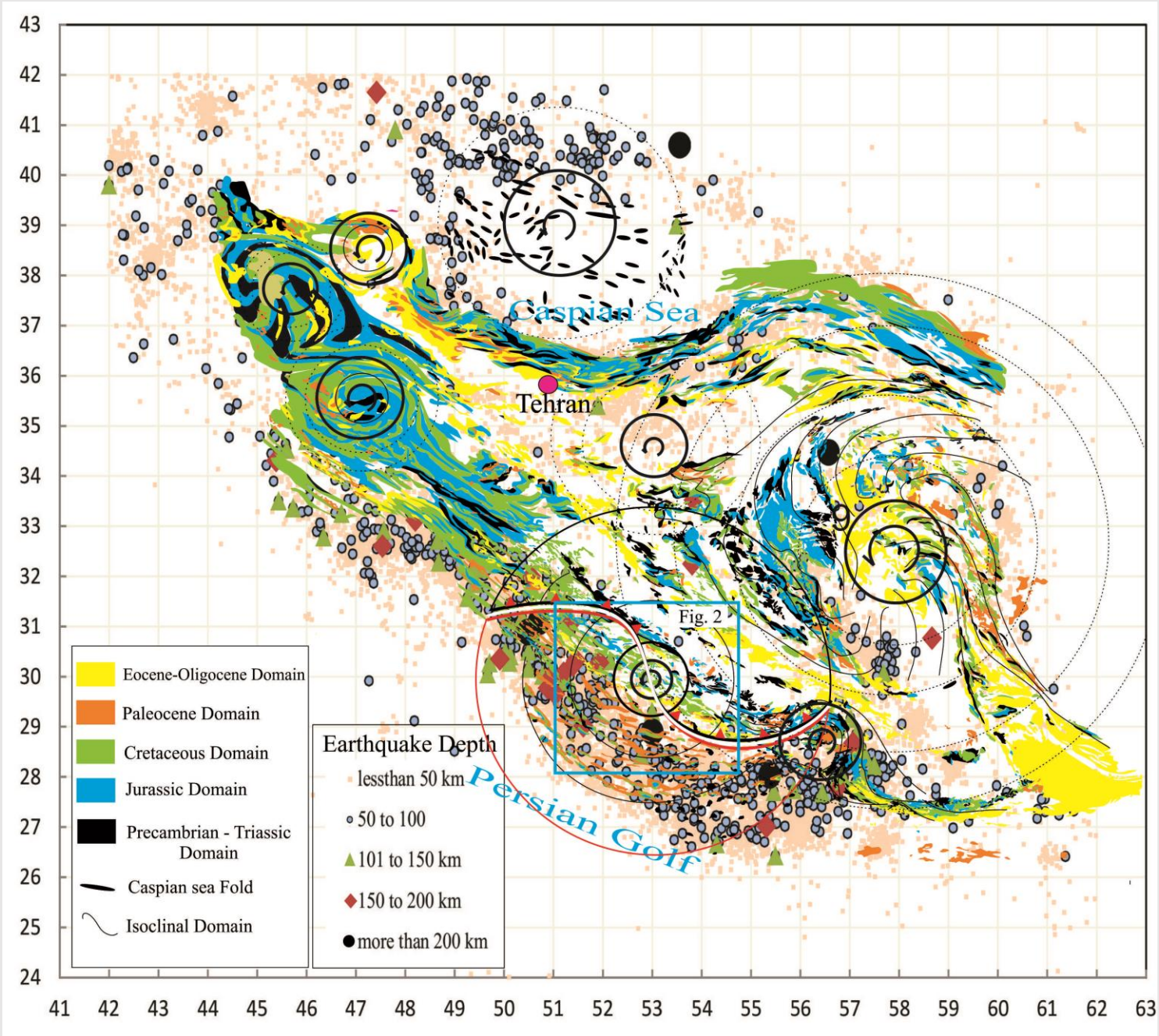
Using **data** from all **faults** (active and inactive) **of mobile belt** between **Eurasia** and **Gondwana** to identify the **major active faults**.



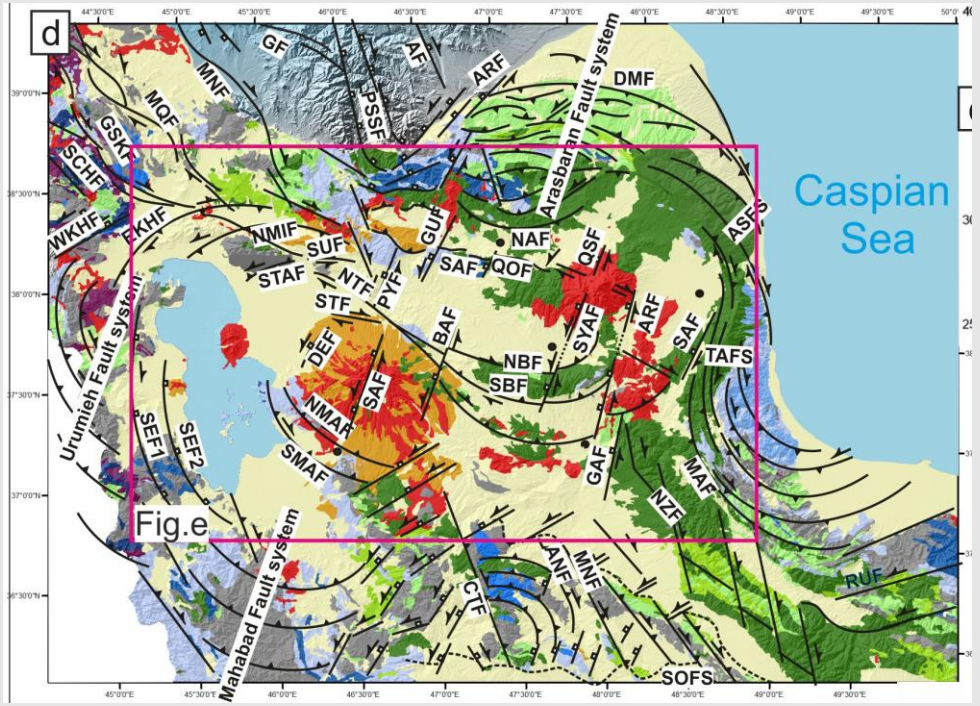
Seismotectonic map

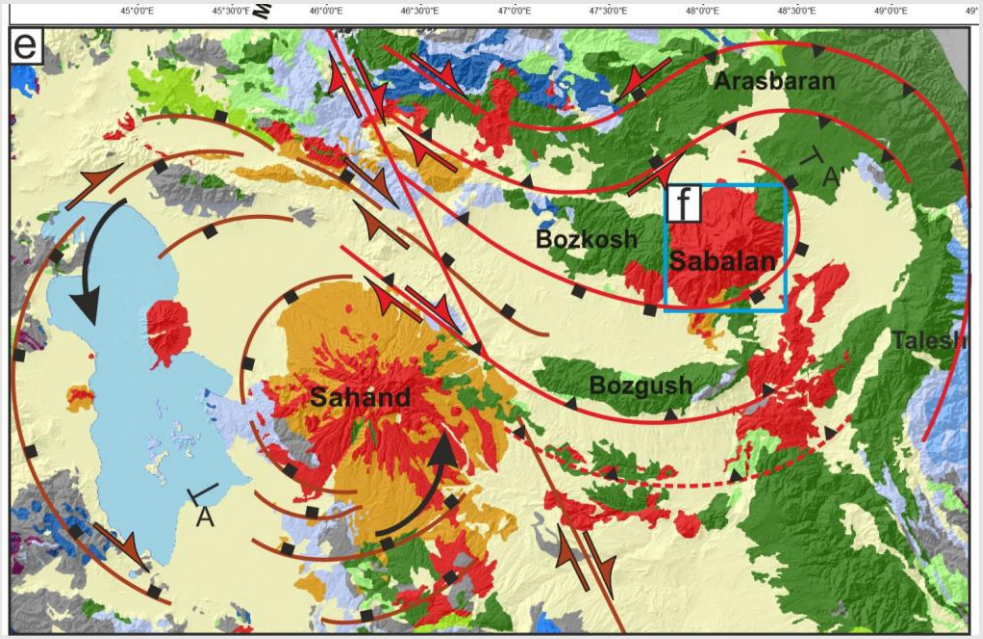
- Boundaries of **spiroclast** are specified by **suture zones** or **major ancient fractures.**
- There are defined **relations** between **different spiroclasts.**
- By **recognition** of the **deformation pattern** in the **location of spiroclasts,** deformation pattern in different parts of **spiroclast** can be predicted.
- This finding **is critical in geological investigation.**
- Especially in **earthquake prediction.**

Spyroclast (Spiral orogenic porphyroclas) map of Iran



Plotting all the faults on this map to find the relation between **faults** and **spiroclast** and separate the major and minor faults (e.g. the Tabriz fault).





Economic, Financial, Commercial

- The need for the project has **strong economic reasoning**.
- **Earthquake prediction** in this project is construed as the identification of **active faults in project impact area**.

- The **doubling of the direct economic losses** caused by **earthquakes** occurs when earthquake magnitude **increases at 13 percent rate**.

- Since **mineral resources** have close relation with **the fault systems** and indirectly it can **play an important role** in **mineral exploration**.

- **This project** may give considerable impetus for **economic gains including employment**, **industrial development**, **trade value, etc.**

Economic, Financial, Commercial

- To be able to predict future **economic losses**, the present project will develop **a qualitatively** new model – "**Spiroclast Model**" of the ECO region.

- the deformation pattern in the mobile belt of the Gondwana and Eurasia plates will be identified and **plotted on Spiroclast map**.

Team members

Project will be executed by effort of the members (human skill) as follows:

- Program Director/Principal Researcher: **Dr. Ramin Elyaszadeh**
- Communications/Social Scientist: **Dr. Akbar Sohrabi**
- Co-Researchers: **Dr. Hadiseh Mansouri**
- Administration Manager: **Dr. Ata Allah Nadiri**

Project work schedule

Project stages	Project works to complete (%)	Project duration (in months)											
		1	2	3	4	5	6	7	8	9	10	11	12
I. Project impact area assessment and Inception report (2 months).	10%												
II. Processing and integration of project via Midterm report (7 months).	60%												
III. Providing Spiroclast maps of ECO countries, ECO Spiroclast Tectonic Model and Final report (3 months).	30%												

References

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Thank you!