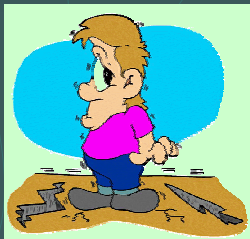


# BENEFITS OF GEODETIC TECHNIQUES ON EARTHQUAKE RESEARCHES

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## Questions?...



- What is an earthquake?
- What causes earthquakes?
- How does an earthquake happen?
- Where do earthquakes happen?
- Is there any way to prevent earthquakes?
- Can earthquakes be predicted?



An earthquake is caused by a sudden slip on a fault. Stresses in the earth's outer layer push the sides of the fault together. Stress builds up and the rocks slip suddenly, releasing energy in waves that travel through the earth's crust and cause the shaking that we feel during an earthquake.

## CRUSTAL DEFORMATION

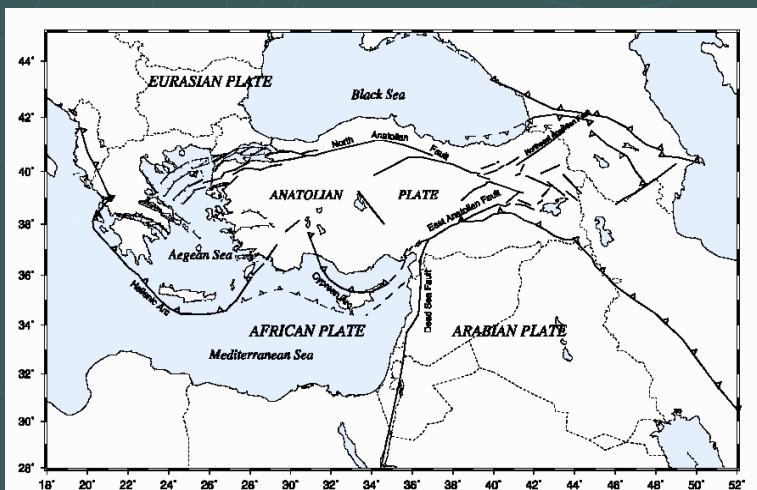


Figure 1: Tectonics of Turkey

**Crustal deformation** induced by the motion of tectonic plates produces a wide variety of landforms at the surface of the Earth and their size depends on the duration of the process involved in their formation.

**Deformation monitoring** is conducted for the purpose of detecting and interpreting small changes in the geometric status of the earth. With the rapid developments in the field of modern geodesy, and with the unprecedented accuracy achievable in geodetic measurements using advanced techniques, the geodetic methods have gained wider acceptance world-wide for monitoring crustal dynamics for earthquake studies. Monitoring crustal deformation is always vital in disaster precaution.

## MONITORING CRUSTAL DEFORMATION

To study seismically active fault systems, it is important to measure both the long-term rate of deformation and the short-term deformation associated with the seismic activity along individual faults. The first type of measurement requires accurate topographic maps to quantify the cumulative displacement of surfaces. The second type of measurements requires the capacity of estimating displacements of the ground at the millimeter level of precision over short time intervals. Contrary to the geological research, the studies of crustal deformation are based on the analysis of repeated geodetic measurements, and their combination with results of other geophysical investigations.

## Multidisciplinary Studies

- Investigations the Earth's crust structure
- Monitoring volcanic activities, plate movements and deformations
- Determination of earthquake source parameters
- Examining geographical, historical, and depth distribution of earthquakes
- Earthquake prediction

## Results of Studies

What information about earthquakes is true?

- Theories are improved to understand earthquake mechanism.
- It is possible to say where earthquakes will strike and at what magnitude.
- It isn't possible to say when earthquakes will strike or even at what time intervals.
- There isn't any study and advance to prevent earthquakes
- We need more data
  - on large areas*
  - at long time scales*
  - from different instruments*

## WHAT ARE THE EFFECTS OF EARTHQUAKES?

In 1999, severe earthquakes damaged an extensive area of Marmara Region, particularly Izmit and Golcuk.

- ❖ 17,000 people killed
- ❖ 44,000 people injured
- ❖ 73,000 buildings collapsed
- ❖ 171,000 buildings with moderate to minor damages
- ❖ 16 million people effected
- ❖ 10 cities (64,000 km<sup>2</sup> area) effected
- ❖ 110 km surface fault rupture



Figure 2: A general view of building damage in Golcuk

## Other Studies

- **Determination of earthquake hazard and risk**
- **Design and construction of earthquake-resistant buildings, dams, tunnels, and bridges**
- **Damage and loss determination after earthquakes and recovery activities**
- **Preparing earthquake scenarios and master plans for seismically active regions**
- **Becoming conscious about our actions before, during, and after earthquakes**

## Underlying Theory of Deformation Monitoring

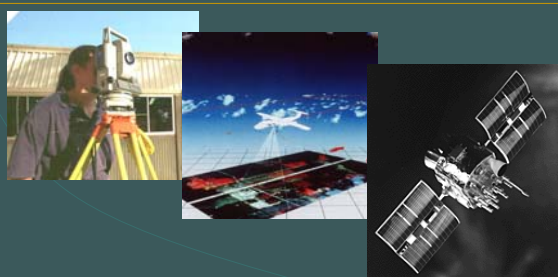
**Geodesy** is the study of the shape of the earth and definition of earth datums  
**Geodetic datums** define the reference systems that describe the size and shape of the earth  
**Map Projections** express the transformation of a curved earth to a flat map

## Data Acquisition Using Surveying Field Methodology

### Measurements and Equipment...



Technological progress, changed measuring tasks and steadily increasing accuracy requirements necessarily lead to the new and continued development of measuring instruments.



## Geodetic Contributions

- Monitoring global geodynamic phenomenon (polar motion, earth rotation and tides, plate movements)
- Determination of the Earth's gravity field and gravity changes
- Monitoring volcanic activities, plate movements and recent crustal movements
- Monitoring effects of earthquakes, and estimating the structural deformations in large engineering structures
- Compiling data from a variety of sources for GIS

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