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Analysis types as a basis for teaching structural geology

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Structural geology courses traditionally begin with an outline of the physical principles of stress, strain and rheology, moving on to descriptions of structures from a range of tectonic settings. This progression from theory to application can confuse students, especially those with limited background in physics and mathematics. It also fails to motivate students when the applications of techniques are unclear. The end result can be a vague understanding of several techniques and a lack of engagement with structural geology beyond a very basic level.

We suggest that structural geology should be taught in the context to seven distinct types of structural analysis, each with their own uses, data and techniques. This works especially well when addressing specific problems using a particular dataset. For example, a student project to determine the fluid flow history of an area would involve the following seven structural analyses:

1. Giving a basic geological description of structures in a study area, including field sketching, mapping, systematic description of photographs, etc.
2. Quantifying the geometry and topology of structures, including section drawing, plotting stereograms, statistical analysis of data, map interpretation, etc.
3. Determining relative (and actual) ages based on the observed relationships between structures, integration with sedimentology and stratigraphy, etc.
4. Understanding the kinematics of the area, including section restoration and balancing.
5. Relating the structures to regional tectonics, basin evolution, metamorphism, etc.
6. Interpreting the mechanical behaviour of the rocks through time and in terms of the causative stresses.
7. Developing a model for the fluid flow, e.g. in the context of hydrocarbons (migration, trapping and production), groundwater systems, waste management, hydrothermal power, development of a mineral deposit, etc.

In this way, a course is tailored to learning how to solve specific problems in structural geology and tectonics. Students learn how to develop a study for any particular purpose, including how and why to select appropriate workflows and techniques. The important first principles and apparently abstract techniques better understood in the context of specific applications.

This approach is especially useful for focussing students during fieldwork. They can be set a specific problem to solve and design an appropriate workflow, collect the necessary data and use the correct analyses before, during and after fieldwork. This would provide strong and practical links between what they are taught during lectures and what they learn during fieldwork.