

The construction of balanced cross-sections

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A GEOLOGICAL cross-section should integrate all known borehole, geophysical and surface geological data and, wherever possible, information off the line of section should be projected down-plunge on to the section. The line of section should be chosen to lie parallel to the slip or movement direction so that the section can be balanced. An oblique section through cylindrical fold structures can still be balanced because during deformation the amount of material leaving the cross-section equals the amount entering the section. However, sections through non-cylindrical fold structures can be balanced only in the slip direction. Sections which cross oblique or lateral ramps cannot, in general, be balanced.

One guideline which a geologist should apply during the section construction is structural style. That is, the structures drawn on the section are those that can be seen in the area in cliffs, road cuts, mountain sides, etc. The use of these structures leads to an *admissible* cross-section.

Additionally, a restored as well as a deformed-state cross-section should be constructed at the same time. Usually, plane strain is assumed to exist in the plane of the section. If a section can be restored to an unstrained state it is a *viable* cross-section.

By definition, a *balanced* cross-section is both *viable* and *admissible*.

There are four levels of confidence in geological cross-sections.

(1) *An unbalanced section*. This represents a preliminary investigation of the section showing conjectural structures.

(2) *An unrestorable cross-section*. This can arise from an unfortunate choice of line of section. For instance a section which crosses oblique thrust ramps cannot be restored to the undeformed state. Such a section could still be valid but the interpretation cannot be helped by balancing.

(3) *A restorable and admissible cross-section*. This section contains tectonic structures which satisfy clearly-stated rules (e.g. thrusts always cut up-section in the direction of transport, extension faults always cut down, etc.). Ideally a geologist should begin at this level of confidence by *simultaneously* constructing deformed and restored sections.

(4) *A valid balanced cross-section*. A balanced section is not a unique solution. But if the section integrates various sources of data in a quantitative manner and additional work is carried out at the surface, in down-plunge projection, in wells, using seismic, gravity and aeromagnetic data, a section may be found which is sufficiently restrictive with little room for alternative interpretation.

† This posthumous contribution by David Elliott was written by J. R. Hossack from his notes which were taken during a conversation between them.