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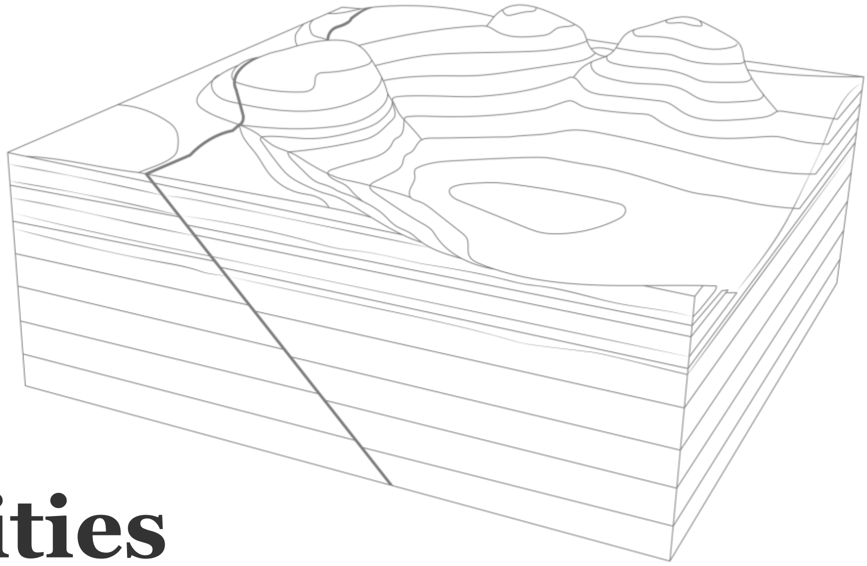

Lesson plan

Unconformities and geological histories: conformable and unconformable contacts

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Learning objectives:

- Distinguish unconformities from conformable contacts
- Identify different types of unconformities
- Interpret the full geological history of an area using conformable and unconformable contacts within a sequence

Key Visible Geology skills:

- Apply unconformities to a model
- Apply dikes to a model
- Use the History tab to edit geological histories

Timelines:

- Workflow 1 – 5: ~30 mins
- Questions and exercise: ~30 mins

Glossary:

- See page 6

VisibleGeology

Unconformities

Geological **contacts** are the boundaries, surfaces or interfaces where two different geological units meet. In sedimentary rocks, these are typically horizontal surfaces as changes in the local environment (e.g., sea level rise) cause different depositional processes to accumulate different types of sediment. We call these types of contacts **conformable** because there was no significant time break between the deposition of each successive layer. By interpreting the deposition environment of each layer from bottom to top, we can then reconstruct a *continuous* **geological history** of that area. However, geological layers do not always build up in a nice stack! Where significant time breaks exist within a stratigraphic record, the contacts between certain layers are no longer conformable and we describe these contacts as **unconformable** or **unconformities**. There are multiple different types of unconformities depending on what the younger layers on top are sitting on! Curious to find out more? Let's dive in!

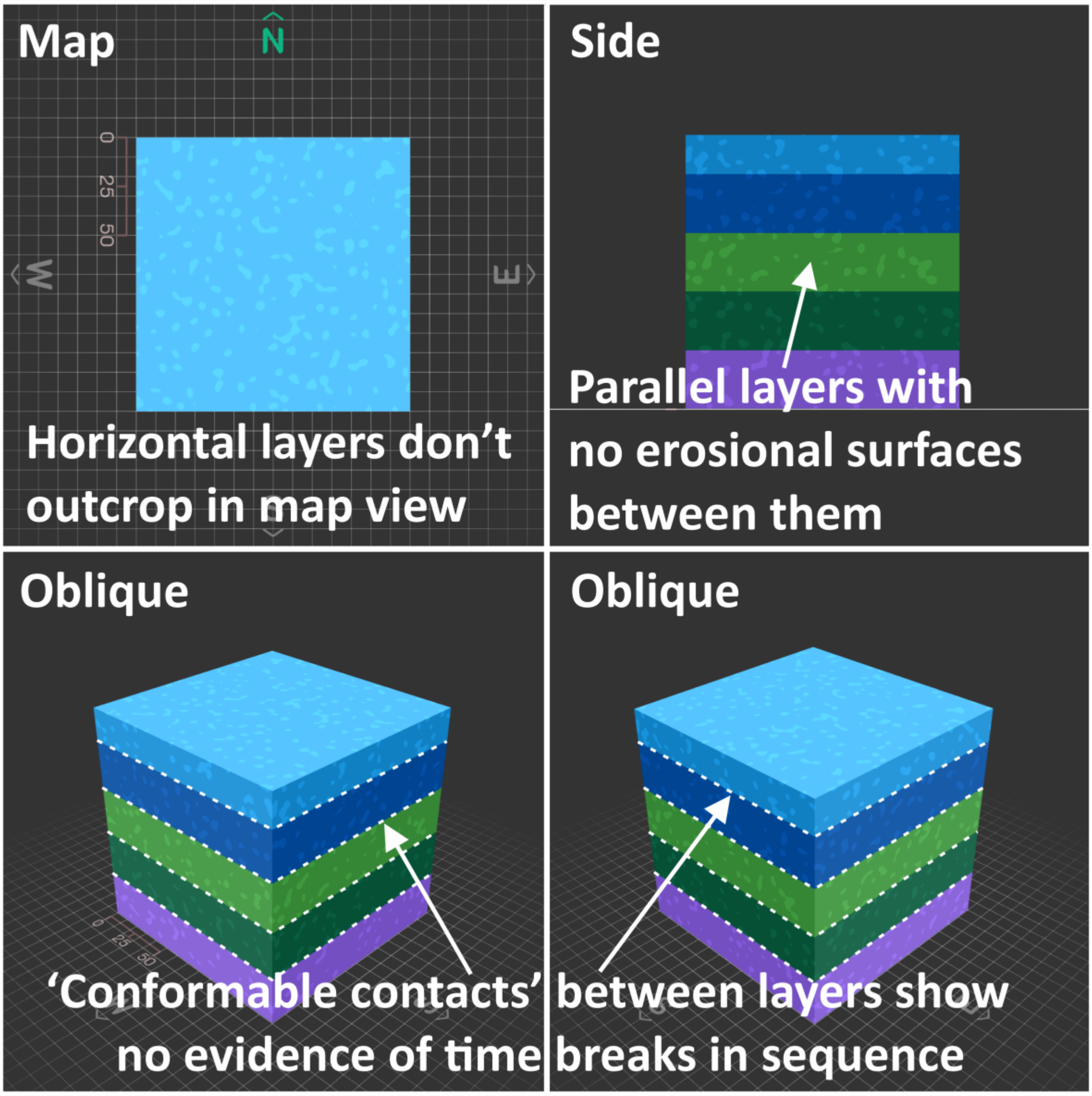
Workflow

1. First, add layers until the block is filled

   Layers -> Add

ⓘ Learning observation!

These parallel layers have **conformable contacts**. This means they were deposited in a continuous sequence with no significant time breaks between them. By interpreting their formation environments individually, we can therefore reconstruct the continuous history of this area without worrying about any missing periods of time!

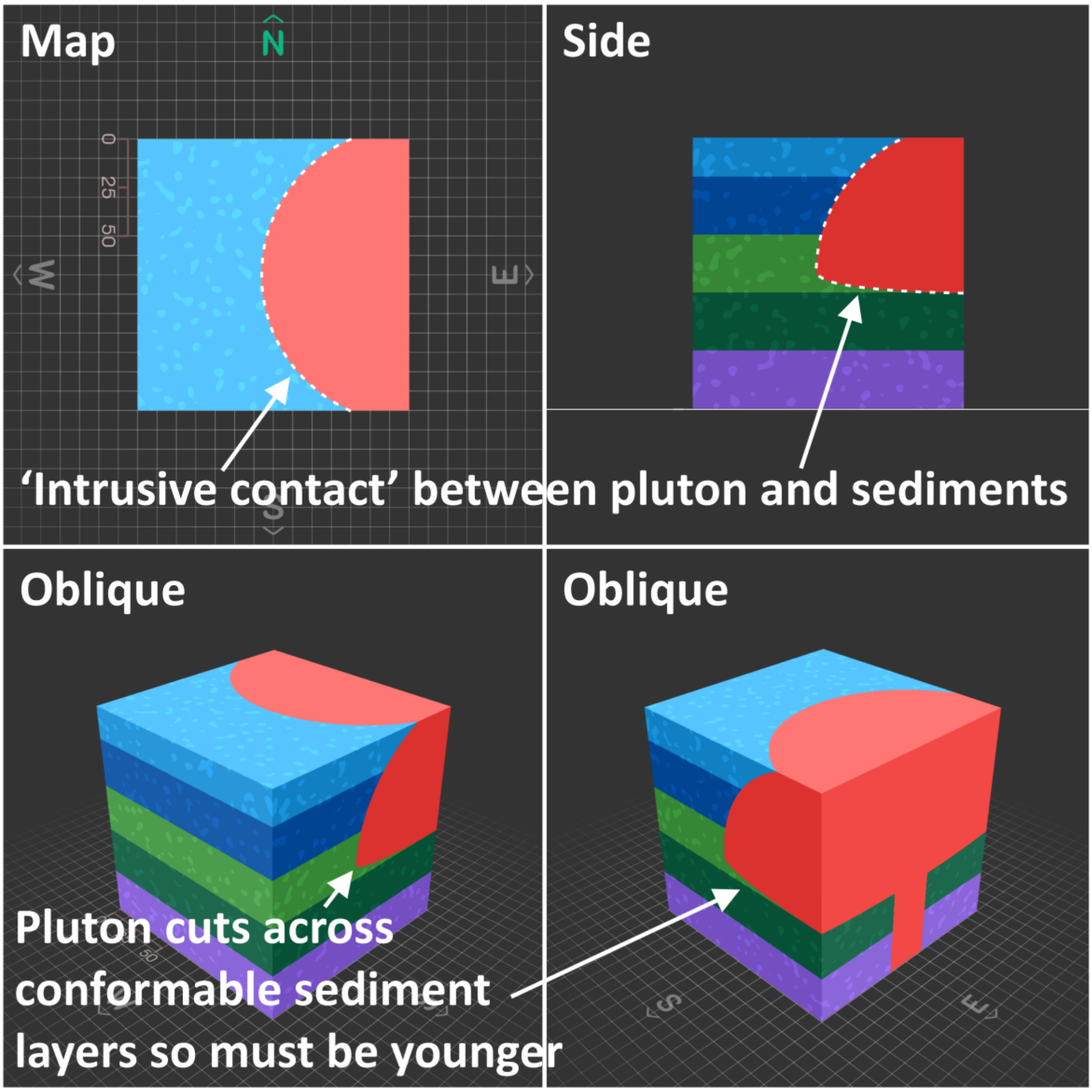


2. But what happens if an igneous rock (i.e., magma) cuts up through our nice conformable layers? Add a pluton and find out!

   Event -> Pluton -> Cap radius = 105, Dike radius = 14, Trend = 000, Plunge = 90 -> Apply

ⓘ Learning observation!

The contact between any igneous intrusion (dike, sill, pluton etc.) and its host rock is called an **intrusive contact** (for more on igneous intrusions see the 'Igneous Intrusions' module!). The contact between the pluton and the surrounding horizontal layers is also a **cross-cutting contact**. It was not deposited neatly on top of the stack but instead cuts through the layers and so must be *younger* than the host rocks surrounding it. Note that this is **not** a type of unconformity (as it's not a sedimentary relationship) but is often confused as one!



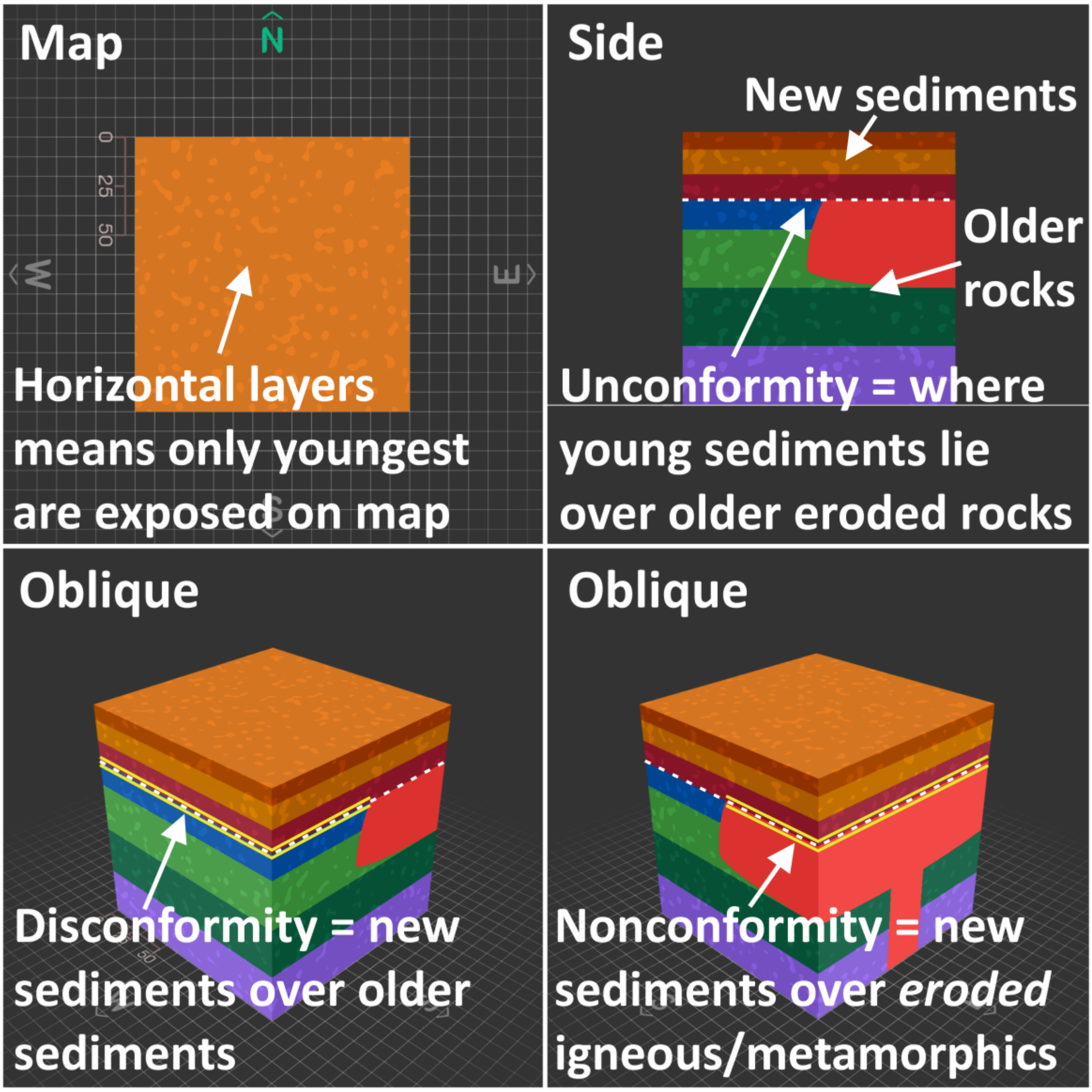
Notice how the pluton is already exposed in map view here (and in side view the top is truncated). This implies a period of erosion has taken place since it was intruded to expose it!

3. External forces such as climate change or tectonic movement can quickly change the local depositional environment. For example, a drop in global sea level can expose marine sediments to rain, wind and waves, or tectonic movements can change river pathways depriving an area on land of sediment. Suddenly, an area that was steadily building nice conformable layers by continuous sediment deposition is no longer receiving sediment and is now exposed to erosional processes. If significant time passes (i.e., hundreds to thousands of years) before sediment deposition begins again in that area, the older layers below will be separated from the new layers above by an *erosional surface*. To recreate this kind of time break within a sequence, apply an unconformity to your model!

   Event -> Unconformity -> Apply

ⓘ Learning observation!

An **unconformity** is where young horizontal sediments lie over eroded older rocks below. The type of unconformity changes depending on the type of rocks the new sediments lie over. The contact where the older sedimentary layers we created before meet the new younger layers above is called a **disconformity**. A **disconformity** means the older layers below and the younger layers above are still approximately *parallel*, however they are separated by an **erosional surface** and therefore a significant time break. In the field, erosional surfaces can be identified by their undulating profile, burrows and bioturbation and/or signs of weathering (e.g., they might be slightly red from oxidation of iron minerals). We can't see these kinds of features in Visible Geology, but the truncated pluton only cutting through the older layers tells us significant erosion (and therefore a large time break) happened between the deposition of the older and younger layers! The contact between the eroded pluton and the new sediments above is called a **nonconformity**. A **nonconformity** applies to a contact where new young sediments lie over *eroded* large-scale igneous or metamorphic rocks.



4. Now this is all well and good when the layers are parallel, but how do we describe it when the rocks on either side of an unconformity are not parallel? Apply a tilt to all the rocks in your model.

   Event -> Tilt -> Strike = 000, Dip = 45 -> Apply

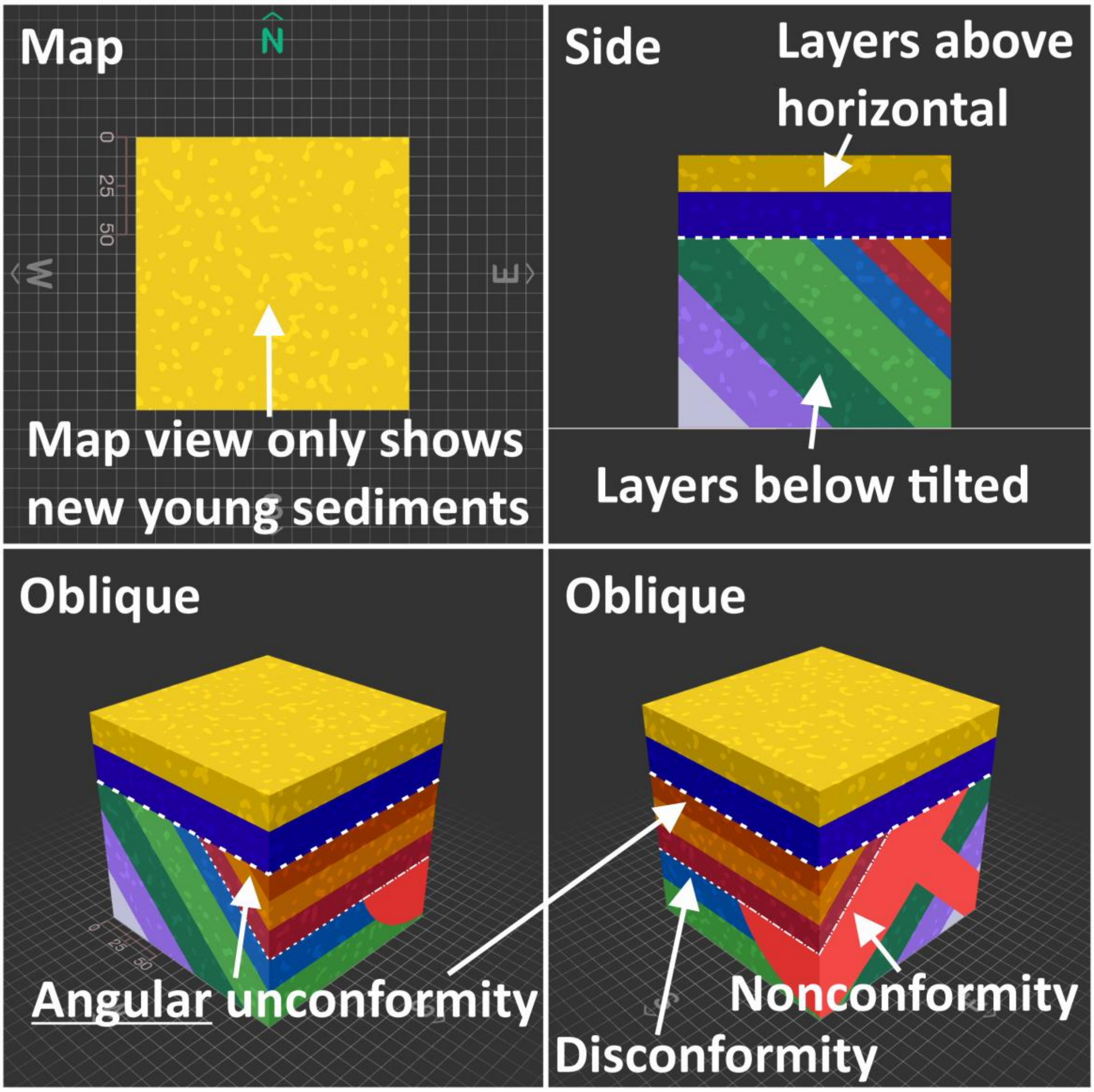
5. Then, add another unconformity over the top!

   Event -> Unconformity -> Apply

ⓘ Learning observation!

We have now made an **angular unconformity.** This is where an erosional surface separates younger horizontal units above ***tilted*** older units below. Notice how we can now see three types of unconformity in our model: the *angular unconformity* between the horizontal and tilted units, the *disconformity* between the oldest group and middle group of sediments, and the *nonconformity* between the eroded pluton and the middle group of sediments.

There is a fourth type of unconformity called a ***paraconformity***. This type is not easily seen at all in maps, cross-sections or 3D models as the sedimentary units above and below are parallel and there is often no obvious sign of erosion between. *Paraconformities* are usually discovered by dating fossils present in the layers that show large time gaps in their evolution.



6. In Visible Geology, the **Legend** on the left-hand side of your screen gives the names of each coloured unit in your model, listed in age order from oldest at the bottom to youngest at the top. While this represents the order the rocks were created in, it does not give us the full story of what happened here to create the structures we see in our model. To tell the full story (i.e., the **geological history**), we can use the **History** tab. Here, every step we've taken so far in Visible Geology is recorded, again from oldest at the bottom to youngest at the top.
    a. First, write down in full sentences the geological history of your block model. Use the names from the legend to describe each layer and the order they were formed in, going from oldest to youngest. Use the History tab to describe the relevant events (e.g., unconformity) at the correct time within your geological history. See below for a short example.
    b. By clicking on an event (e.g., dike) it returns the model to that event. You can edit an event using the edit logo, e.g., if you want to change the tilt angle of the layers below the angular unconformity. Clicking and dragging on the left side of each event lets you change the order of the events! Move the dike upwards in the sequence until it comes after the tilting of the layers but before the final unconformity. How would this change your geological history? (Hint: look at the Legend tab now!)

Geological history example extract:

"…After the dike intruded and cooled, a period of erosion took place creating a disconformity between the greywacke and the younger layers above. Mudstone was then deposited over the top, followed by the limestone and sandstone layers…"

Questions

- What regional tectonic changes might cause a disconformity to occur within the geological record?
- What environmental changes might create a disconformity in the geological record?
- Would you expect angular unconformities to represent a relatively short or long period of time between the deposition of the tilted older beds and the horizontal younger ones?

Glossary:

Geological contact: The interface where two different rock types meet.

Conformable contact: The interface between two sedimentary units deposited one above the other with no significant time break between.

Cross-cutting: Where one younger rock type (typically igneous) cuts across pre-existing layers or features of older host rocks.

Intrusive contact: The interface between an intruding igneous rock and the surrounding host rock.

Unconformable contact: A contact where younger sediments are deposited over older eroded rocks.

Nonconformity: A contact where young sediments lie over eroded igneous or metamorphic rocks below.

Disconformity: A contact where young sediments lie over eroded older sediments below.

Angular unconformity: A contact where young sediments lie over tilted eroded older sediments below.

Geological history: The story of how each geological rock type within a given area was created (and deformed/eroded if appropriate), written in chronological order from oldest to youngest.

Real-world examples

The contact between these mudstone (grey, below) and sandstone (orange, above) layers is a disconformity. We know this because the sediment filling preserved burrows within the mudstone (white arrow) is different to the overlying sandstone, and so must have come from a different unit that was eroded away before the sandstone was deposited. Cape Foulwind, Aotearoa New Zealand. Photo: Henry Hoult

Geologist's James Hutton's famous angular unconformity (dashed) located at Siccar Point in Scotland. The older vertical beds are 65 million years older than the layers above the unconformity. Photo: Kate Pedley