



Geological structures exposed.

Structural chronology

Nigel:

Well we're back in the Inner Zone looking at structures, and what I can see here is some fairly complicated folding which is clearly indicative of ductile deformation but can you take us a bit further than that?

John:

Okay, well let's start to build up a picture. First of all let's just point out that there are some quartz veins and quartz patches here, but we can see that there is a colour change which represents bedding, particularly, well displayed across this part of the outcrop. So we can follow that bedding and we can see that it is folded around folds in that shape. So the first thing we can establish is that there is bedding in these rocks which is folded, and those folds, if we see a fold that are part of the ductile deformation, then we ought to ask ourselves where there is a cleavage associated with them. And there certainly is - over here a natural plane of cleavage.

Nigel:

Yes, they've been weathered out in a space way running down here and here.

John:

It's interesting that you would use the word 'space' because that tells me that there's perhaps something more going on in these rocks than we've been able to see so far. Because I would expect a lithology like this, one that is very rich in phyllosilicate minerals with platy grains that can be easily be oriented and develop the cleavage, I would expect to see a very well platy cleavage forming in these rocks, and the fact that you are seeing space cleavage here means that we really ought to look a little more carefully to see if there's actually something more complex happening. And that perhaps the obvious folds that we're seeing here might not be the first deformation that had affected these rocks. And I think the place where we see some evidence for that is further down the outcrop over here. And we can see one of these quartz veins and trace it round a fold of that shape. Now that's very different both in terms of shape and orientation from the folds that you've just been seeing. The fold is much tighter for a start; it's almost what we term isoclinal. The angle between the fold limbs is very, very tight indeed.

Nigel:

And the axial planes appear to be parallel to bedding.

John:

The axial planes are parallel to the bedding and the layering in this rock, aren't they? And we can just about see that other cleavage here. And that cleavage is just coming straight across these folds, almost at right angles to their axis, to their axial planes. It's a later cleavage that cuts right the way across that fold and relates to these other folds that we started off seeing.

Narrator:

From this single outcrop we have been able to recognise older, flat-lying isoclinal folds and a younger spaced cleavage axial planar to more upright folds.

John:

So we're picking up good evidence for a chronology of structures, for a time sequence to these structures, clearly two different episodes of deformation resulting in two different orientations of folds, and with different cleavages.

Narrator:

Another vital aid to unravelling structural chronology is the recognition of fold facing.

John:

Right, we've come over to the south side of Loch Leven now to have a look at these quartzites that contain some of the best cross-bedding in Dalradian quartzite I have ever seen – it's superb. We have got the relationship where these cross beds here are curving in. That means they're asymptotic to that bedding surface and are being truncated, they're being cut off against that surface. So, as a way-up indicator this is as clear as it could possibly be. These rocks are younging in *that* direction.

Nigel:

Okay, that's really interesting because on this side of the outcrop there's a fold, you can see the limbs folding round and arch here, and the axial plane is given away by this surface here. And transferring your younging information over to the fold, the limbs of the fold are younging, that direction, in other words, we're younging as we go *down* the axial plane.

John:

That's the critical piece of evidence, isn't it, that having found the axial plane of the fold, the rocks get *younger* as you go *down* the axial plane. This is a downward facing fold, and the critical thing is that can *only* happen when there is more than one episode of folding in the area.