The Geological record of environmental change

Glaciation: Examining sandstones

M.E. Andrews Deller
We've walked in the direction of dip and we're still on the diamictite but this is a very different block.

Steve Drury
Isn't it. It's sitting on top of the diamictite, chocolate cud, there's no sign of any dropstones in it, it's bedded, and it looks like a sandstone. Yeah, it's certainly not chocolate-coloured inside, it's white, look, it's white so I would suggest this is an impure sandstone. Yeah it's a medium grain quartz sandstone.

M.E. Andrews Deller
So it can't possibly be glaciogenic?

Steve Drury
No I don't think so. So shall we walk to see if we can get some more, see some more sandstones higher in the sequence?

M.E. Andrews Deller
Yes.

Steve Drury
Okey-doke. You know the higher sandstones are white, pure quartz I think, and wonderful plainer bedding.

M.E. Andrews Deller
High energy currents and laminar flow.

Steve Drury
Yeah.

Voice Over
Well-bedded sandstones often contain structures related to the environment of deposition. From a distance ripples of different kinds can sometimes be seen preserved on the bedding planes.

M.E. Andrews Deller
Here are some ripples; they look to me as if they're asymmetrical.

Steve Drury
Yes, so they are. They indicate the current flow; grains transported by the current along this gentler slope and then deposited down- current on the steeper slope, so I think they indicate current flow towards the northern north.

M.E. Andrews Deller
Here are some lovely asymmetric ripples.

Steve Drury
Yep, the crests are going like that and the current direction is in this direction.

M.E. Andrews Deller
So it's completely different from what we saw before?

Steve Drury

It is, yeah.

M.E. Andrews Deller
Here's a ripple in cross-section.

Steve Drury
Yep, and the current direction is again towards northern north.

Voice Over
Sandstone strata can be complicated when seen in cross-section, sometimes showing cross-stratification related to ripple formation. Some clearly expressed sediment transport directions. The structure at the centre preserves laminations that were deposited on the lee slope of a migrating asymmetrical ripple. The direction of dip is that of the ripple-forming current to the northern north. At the top right is a similar structure but in this case current flow was in the opposite direction. An even better example of a migrating ripple in cross-section again shows a northward flow direction. At least on a small scale the sandstones clearly show evidence for shifting directions of water flow. Current indicators in sandstones also occur on a larger scale. The lower part of the cliff shows cross-stratification formed by a large sand wave, a mega-ripple, or sub-aqueous dune. The dip of this kind of large scale cross-stratification indicates southward current flow and high energy currents. The sandstones are full of evidence for alternations and flow direction. This is characteristic of tidal action in shallow water. With two tides each day, and an ebb and a flow for each of them, inevitably evidence for varying current directions will be preserved in tide-dominated sediments. In enclosed basins tidal flow can be extremely powerful and geologists interpret signs of it as evidence for near-shore conditions.

M.E. Andrews Deller
Is it possible to show that these sandstones weren't deposited in glaciogenic conditions 'cos that would really challenge the Snowball Earth hypothesis?

Steve Drury
Well floating ice is not well known for wave action. If we could find evidence for the effects of waves I think that would do it and this bedding plain here, I think it does it. Look at this: rounded, rounded, rounded, some sort of ripples and asymmetrical, I think these are wave ripples.

M.E. Andrews Deller
So they definitely couldn't have been laid down under ice?

Steve Drury
Yeah it looks like it. There was no ice I don't think when this sandstone was laid down.

Voice Over
The symmetry of ripples formed by wave action results from the back and forward movement of particles, a motion induced by waves at the sea surface.

M.E. Andrews Deller
Look, we've come to the top of the sandstone and the boundary, and another diamictite.

Steve Drury
Oh yeah, well, there's two diamictites, one underneath the sandstone so glaciogenic diamictite, tidal sandstone, glaciogenic diamictite.

M.E. Andrews Deller
So we have two different environments?

Steve Drury
Yeah well that's not easy to reconcile with the Snowball Earth hypothesis.