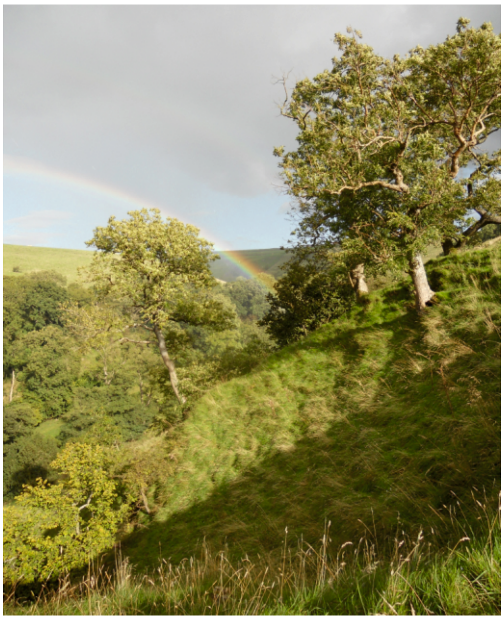
Brimham Rocks

A short field guide

11th SEPTEMBER 2016

O.J.W. **Wakefield**



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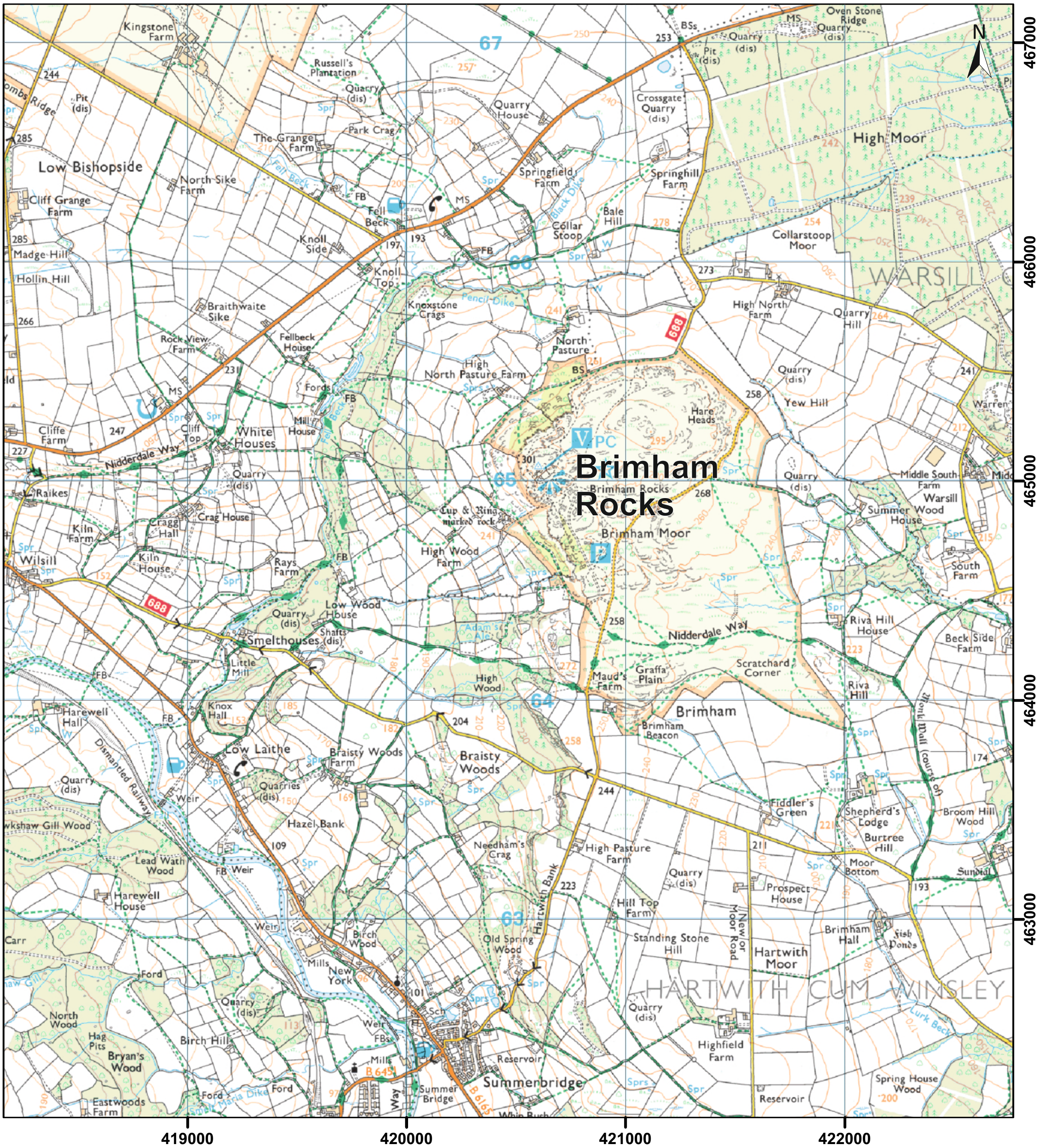
Introduction

Brimham Rocks

National Trust Visitor Park - Brimham Rocks. The site has spectacularly exposed rock pinnacles that allow a three-dimensional insight in to a complex ancient fluvio-deltaic system. This part of the field trip will focus on identifying and interpreting a series of sedimentary structures and relating them to a variety of depositional bedforms.



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Brimham Rocks

Overview
Carboniferous rocks accumulated in a variety of depositional environments including fluvial, deltaic, paralic, shallow- and deep-marine settings (Stone et al., 2010). The accommodation space available to deposit the sediment in the aforementioned environments varied due to complex interplays between active faulting, subsidence and eustatic fluctuations in relative sea level (Stone et al., 2010).

Brimham Grit
The Kinderscoutian (Bashkirian) Brimham Grit exposed in the National Trust Brimham Rocks Park is located east of Pateley Bridge at about ~275 m above OD. The Brimham Grit is primarily characterised by coarse-grained, cross-bedded, feldspathic to subarkosic sandstones. These cross-bedded sandstones commonly occur on a range of scales, stacked in complex vertical and lateral assemblages that were deposited in a fluvio-deltaic system.

Numerous works have looked at a variety of fluvial and deltaic Carboniferous setting within the Pennines (McCabe, 1977; Collinson, 1988; Gawthorpe et al., 1989; Martinsen et al., 1995; Hallsworth and Chisholm, 2008; Waters et al., 2008). Indeed the rocks at Brimham Rocks were first described and the name 'Brimham Grit' was first used by Philips (1836) in his work “Illustrations of the Geology of Yorkshire, Part II”.

Although the Brimham Grit and specifically the Brimham Grit exposed at Brimham Rocks are mentioned in numerous publications (Mackintosh, 1865; Dakyns, 1893; Tonks, 1925; Hudson, 1937; Jones, 1942; Wilson, 1960; Wilson and Thompson, 1965) relatively little detailed work has been undertaken specifically on the Brimham Grit. Only work by Reid (1996) has specifically sought to identify the palaeo-depositional setting for the Brimham Grit. In this work Reid (1996) describes the parts of the Brimham Grit as “alluvial delta-front grit sequence”, which is in turn overlain by erosively based “major channel grit sequence” evolving upwards into “alluvial flood plain sequence” that encompassed a sequence of multi-storey, multi-lateral “fixed chute-like channel complexes”. The palaeoflow direction for the fluvio-deltaic Brimham Grit is generally to the south (Reid, 1996).

A more modern study by Roman Soltan (based at the Fluvial Research Group in Leeds University) has taken a very high-resolution facies and architectural element analysis of all the outcrop at Brimham Rocks. Some of Roman’s initial work is included as part of this field guide and Roman Soltan and the FRG are thanked for allowing this.

****Brimham Rocks has been designated as a Site of Special Scientific Interest (SSSI) as such hammering and sample location is strictly prohibited****

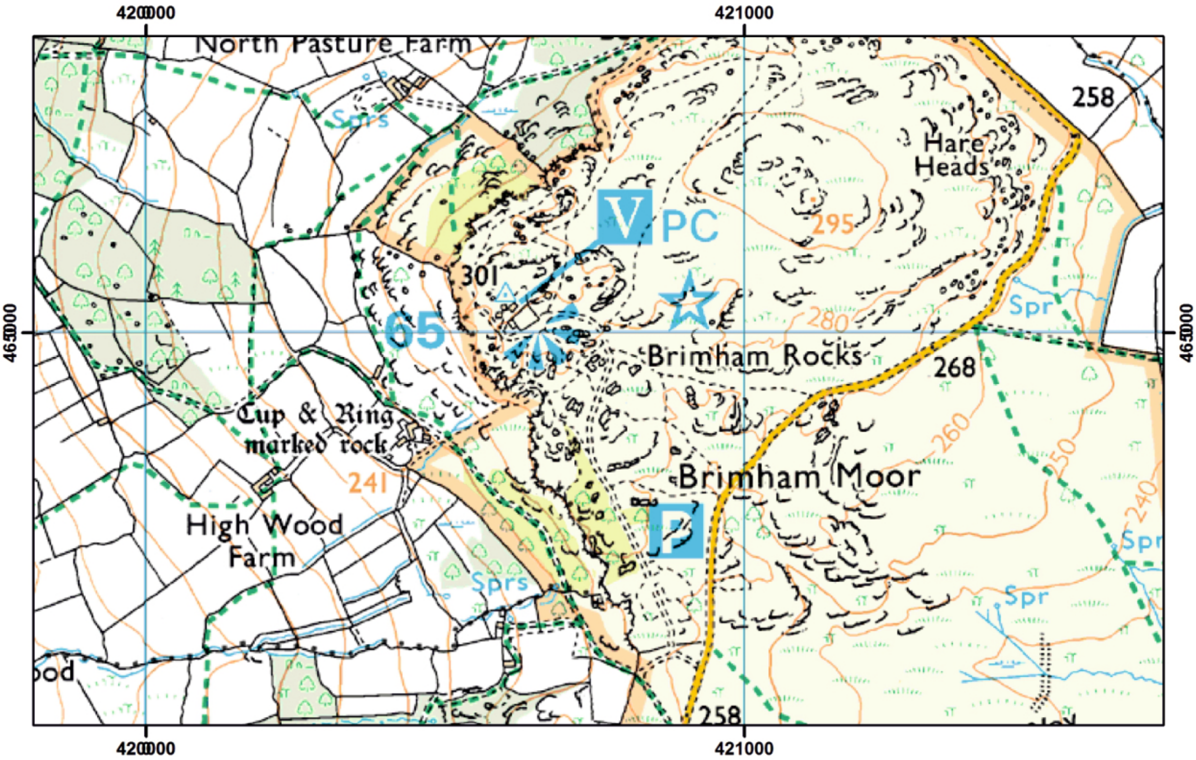
Brimham Rocks

Bradford	Leeds	Harrogate	Patelely Bridge
R2a1 - Bilinguites gracilis MB	R2a1 - Bilinguites gracilis MB inferred position	R2a1 - Bilinguites gracilis MB	Lingula
High Moor Sandstone/Upper Kinderscout Grit	Upper Plompton Grit, High Moor SDST in west of Leeds	Upper Plompton Grit	Upper Brimham Grit
Butterly MB	MB not present	Lingula in Farnham BH	*?Lingula - Brimham Shale*[2]
Doubler Stones SDST/ Lower Kinderscout Grit	Upper Plompton Grit , Doubler Stones SDST in west of Leeds	Unnamed thin sandstone (Doubler Stones in the south west)	*Unnamed fine-grained SDST in Upper Nidderdale*[1]
R1c4 - Reticuloceras coreticulatum MB	R1c4 - Reticuloceras coreticulatum MB	Eccup MB inferred R1c4	*?Lingula - Brimham Shale*[2]
Long Ridge SDST/Lower Kinderscout Grit	Long Ridge SDST in west of Leeds	Long Ridge SDST in south west, thin SDST in Farnham BH	*Unnamed fine-grained SDST in Upper Nidderdale*[1]
R1c3 - Reticuloceras reticulatum MB	R1c - Reticuloceras reticulatum MB	Lingula R1c inferred	Brimham Shale
R1c2 - Reticuloceras reticulatum MB			Brimham Shale
Addingham Edge Grit (=Caley Crags Grit)	Addingham Edge Grit or Lower Plompton Grit Formation	Lower Plompton Grit Formation	Lower or First Brimham Grit
Otley Shell Bed		?R1c1 - Reticuloceras reticulatum MB	Bewerley Shales Ure Shale Bed
SDST (in part former Addlethorpe Grit)	Addlethorpe Grit	Addlethorpe Grit	Libishaw SDST Libishaw Shale Agill SDST
		R1a4 - Reticuloceras todmorense MB	Agill Shale
?R1a2 - Potentially Reticuloceras circumplicatile MB	Cayton Gill Shell Bed	Cayton Gill Shell Bed	Cayton Gill Shell Bed on Cayton Gill Shale
R1a1 - Hodsonites magistrorum MB			

[1] - Position of this unnamed sandstone is not fully constrained and could stratigraphically belong to either shown position

[2] - Position of the highlighted Brimham Shale has not been fully constrained and could stratigraphically belong to either shown position

Brimham Rocks



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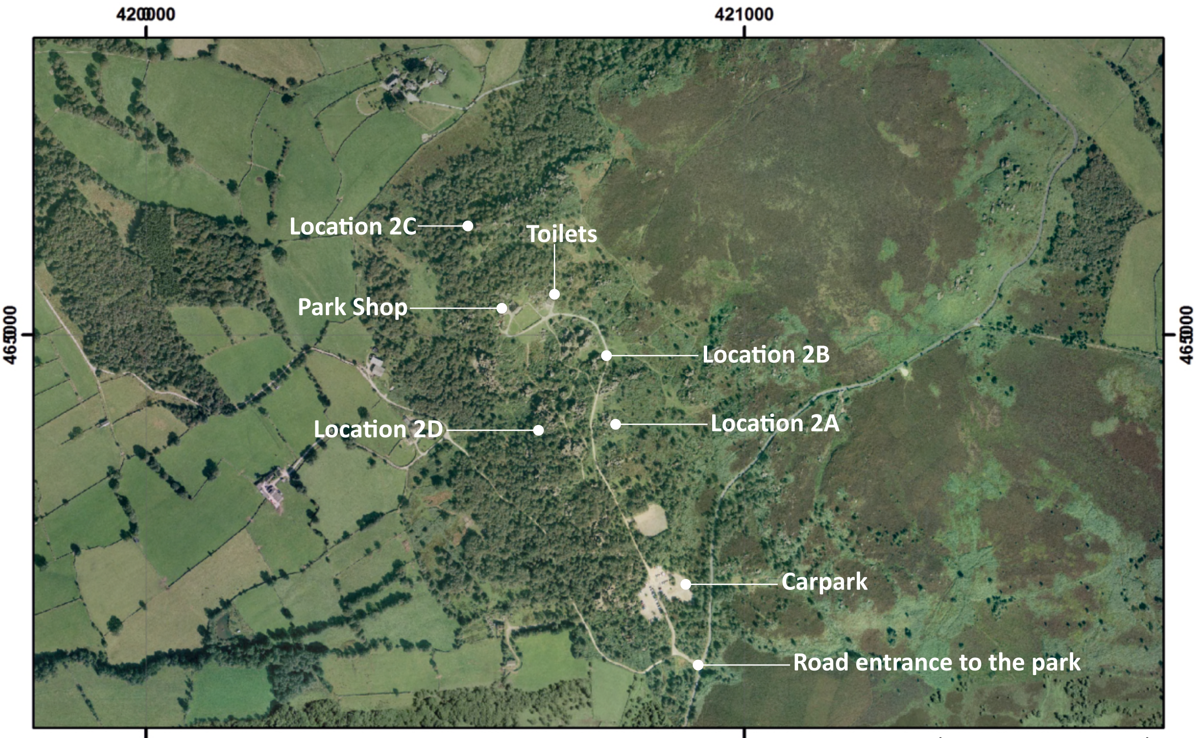

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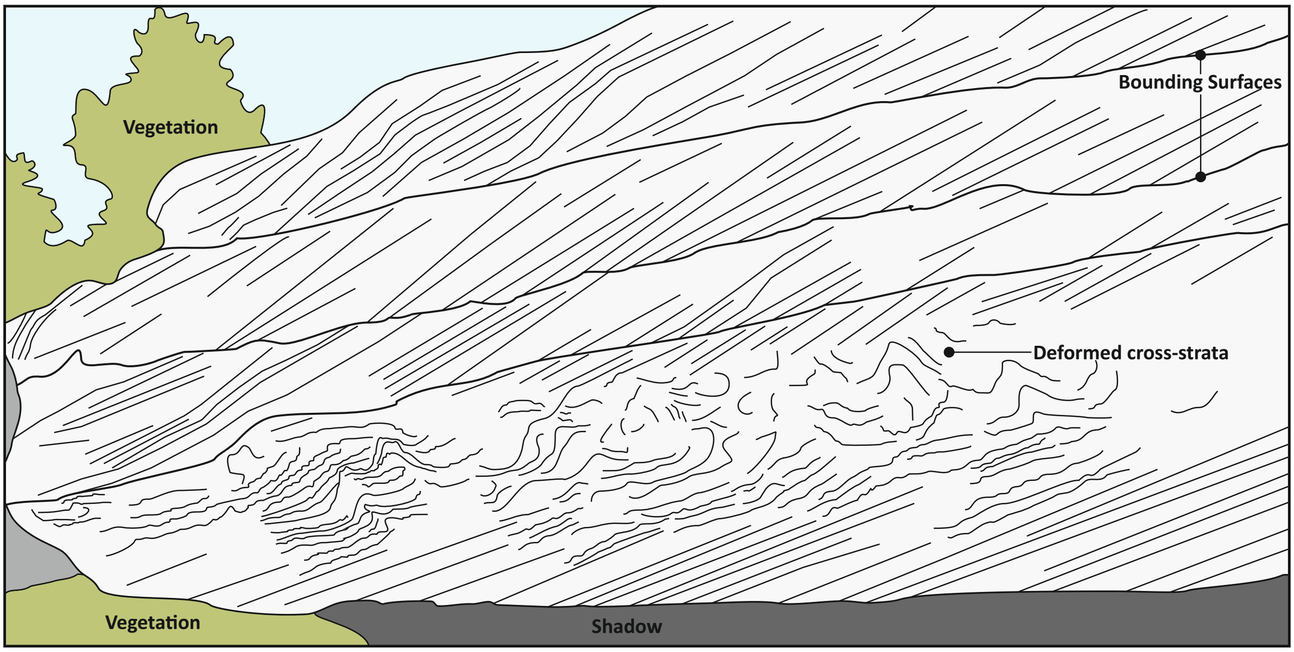
25k OS map and aerial photograph of Brimham Rocks. Localities are highlighted on the aerial photograph.

Brimham Rocks

Location 2A - **Bedform Dewatering**

Dewatering structures isolated within a single cross-bedded set (photo and diagram below). Overlying sets remain undeformed.

Two prevailing interpretations are commonly used to describe the observed dewatering structures; (i) Seismic induced dewatering, (ii) overburden pressured dewatering

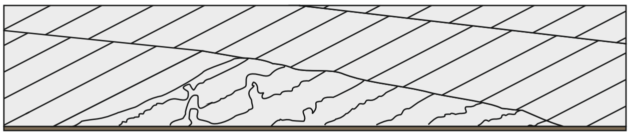


Brimham Rocks

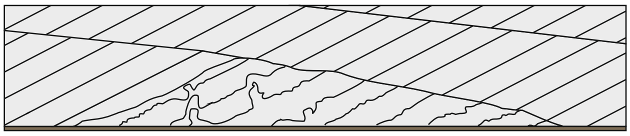
Location 2A - **Bedform Dewatering**

Conceptual two-dimensional cross-sections examples of seismic and overburden associated dewatering mechanisms.

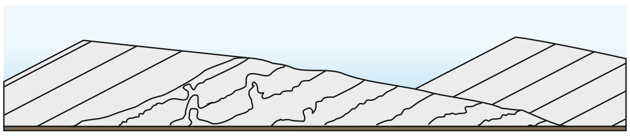
Seismic induced dewatering



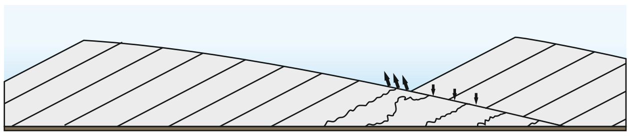
Overburden pressured dewatering



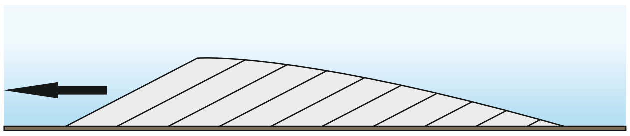
The resultant sedimentary expression varies little between the two different interpreted mechanisms. Seismic induced dewatering would likely effect all active bedforms at the time of the event. Due to the absence of further examples an overburden mechanism is preferred.

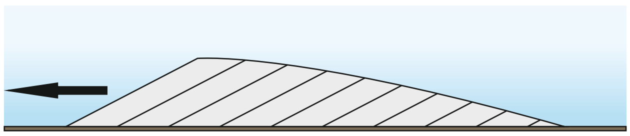


Seismic event disrupts deposited sediment and causes movement. This movement causes slumping of some crossbedding. Water within porespace is pushed out under remobilisation of sediment.



Waterlaiden bedforms migrate. As subsequent bedforms migrate and climb over others the overburden pressure provided by the weight of the climbing bedform causes compaction in the underlying. This reduces porespace and forces water to escape.





In-channel bedform with an active slipface migrates and generates crossbedding as material casades down the bedforms front.

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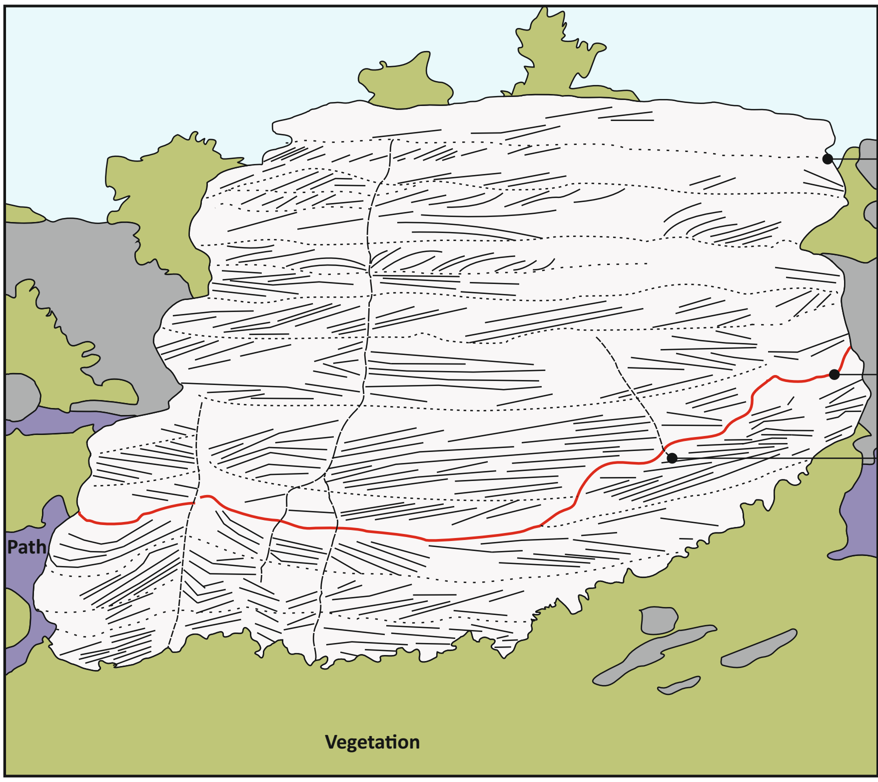
Location 2B - **Channel Bounding Surface**

Rare example at Brimham Rocks of a channel bounding surface. The channel bounding surface is identified by the truncation of the underlying crossbedding sets.

Cross-bedding occurs on a variety of scales and each is linked to the size and type of bedform that created it and the amount of that migrating bedform which has subsequently been preserved.

From this outcrop example we can identify larger 'marcoforms' where the cross-beds exceed 5 m in length. These cross-bed sets were likely created by in-channel migrating barforms.



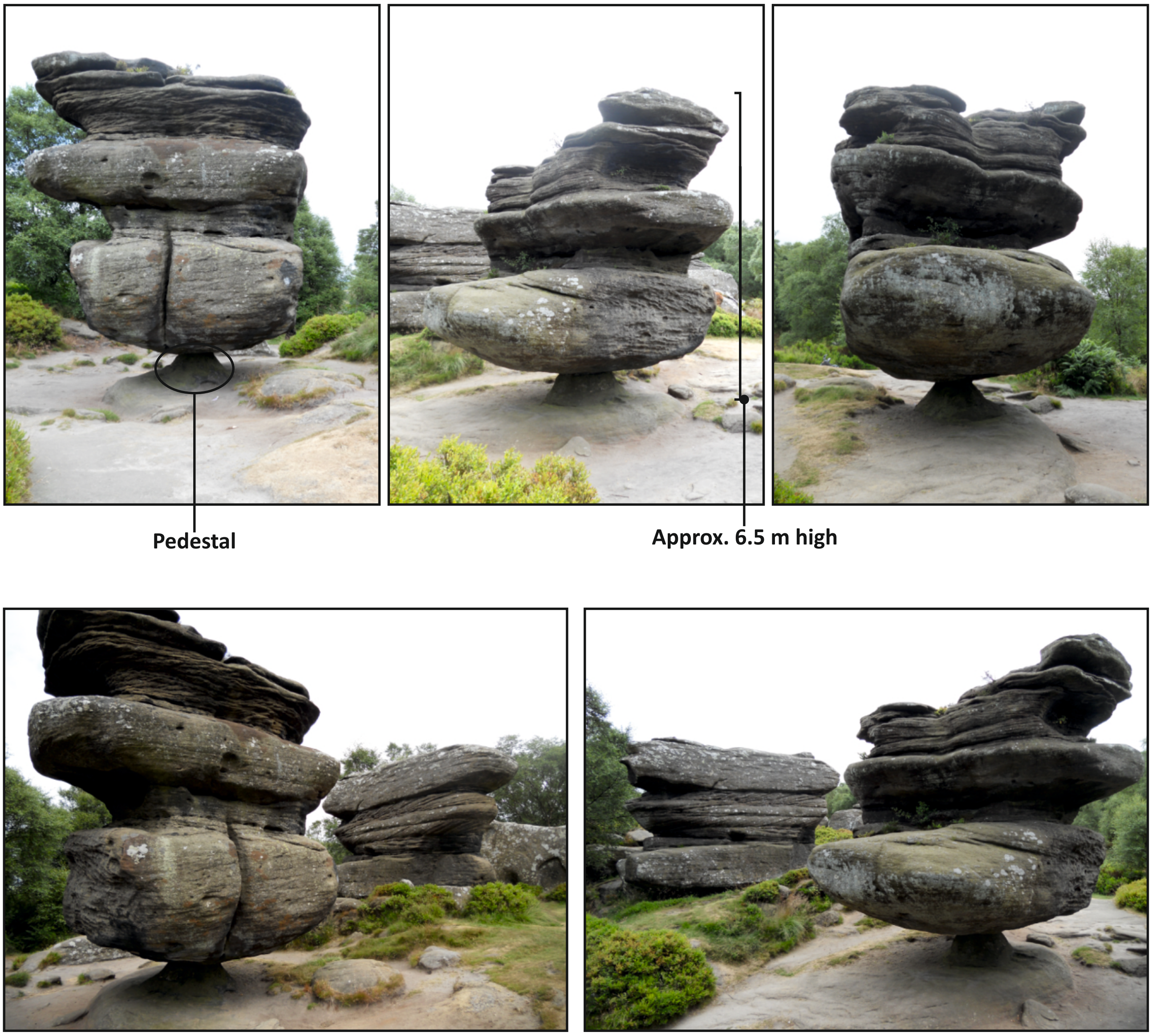
Note that some cross-beds appear to 'curve' and this is likely related to the outcrop face being curved and cross cutting the various bedforms at a variety of changing angles.

Brimham Rocks

Location 2C - **Idol Rock**

Relatively famous example of some of the 'balancing rock' outcrops within the park and an excellent photo stop.

Idol Rock, *pictured below*, is a spectacular example of how much rock can be balanced on such a small pedestal, **but how heavy is Idol Rock?...**



A variety of differently orientated photos of Idol Rock. *Note the size of the pedestal from all orientations*.

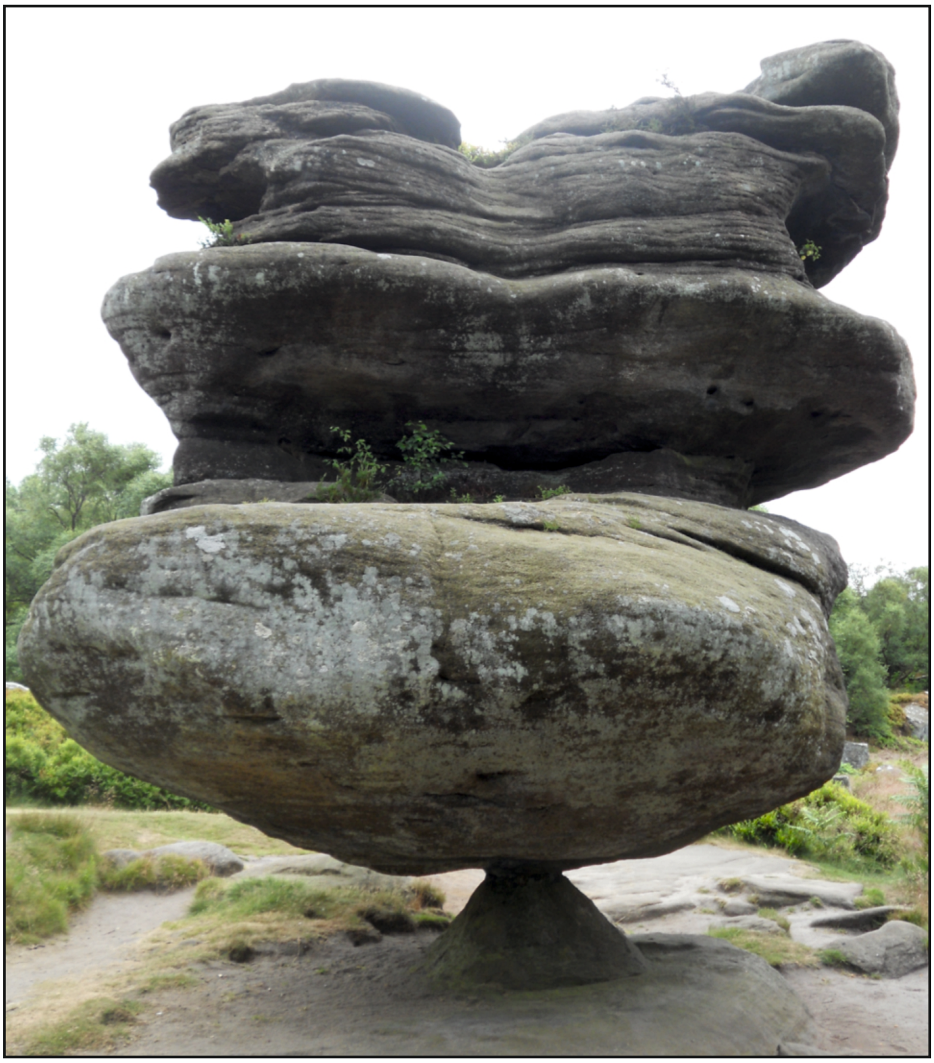
Brimham Rocks

Location 2C - **Idol Rock cont'd**

Applying a little bit of maths using some approximate measurements:

- For ease of calculations if we assume Idol Rock has a simple cylindrical shape with a height of 6.5 m and a width of 4 m then it has an volume of ~81.7 m^3 or 106.8 yd^3.
- Sandstones weigh *, on average*, ~2300 kgs per cubic metre = 3915.5 lbs per cubic yard.
- So Idol Rock weighs ~ 187867 kgs or 414175 lbs.
- Idol Rock sits on an pedestal with an area of ~0.25 m^2 (2.7 ft^2).

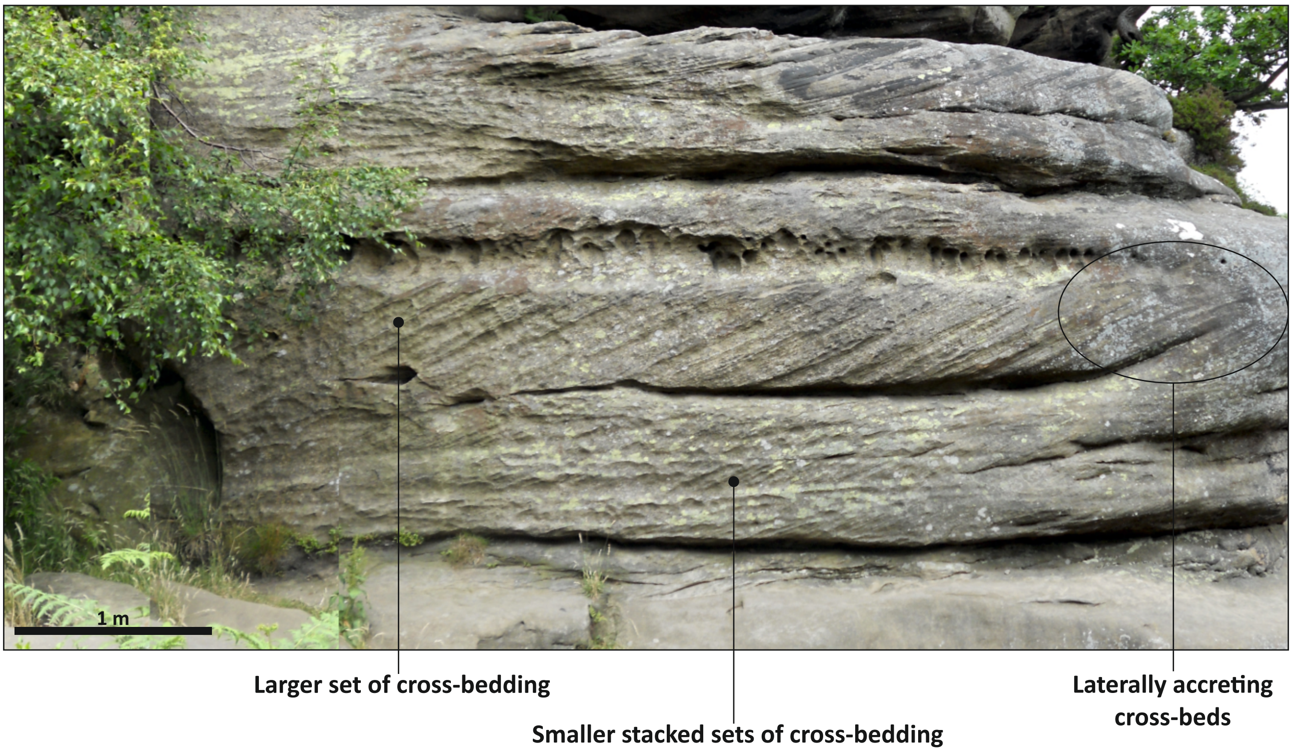
Equivalent to 153 Vauxhall Astras stacked on an area of two dartboards....

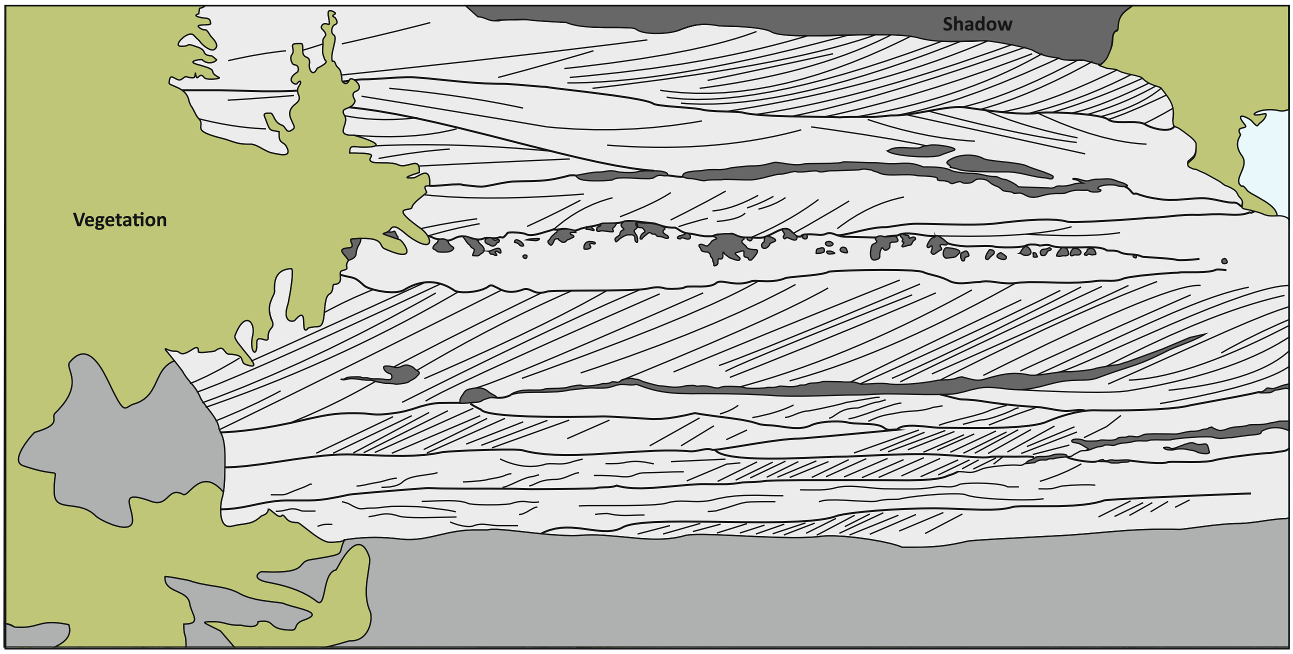


Brimham Rocks

Location 2D - **Lateral Accretation**

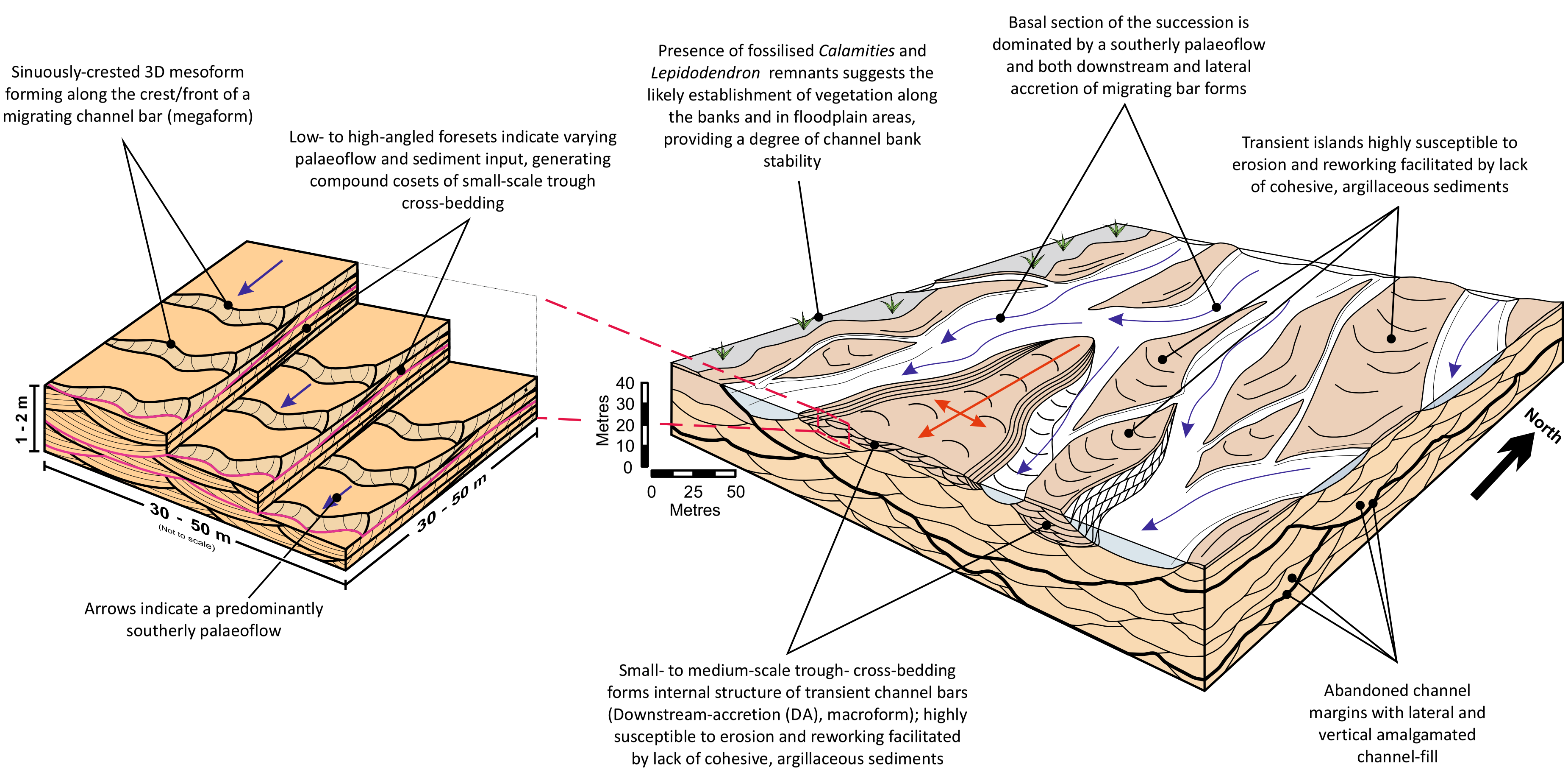
This outcrop exposes an example of lateral accreting cross-bed sets. Rather than this being lateral accretion from a pointbar in a meander loop, this examples of lateral accretion is more likely belonging to an in-channel barform that had a component of lateral movement.





Brimham Rocks

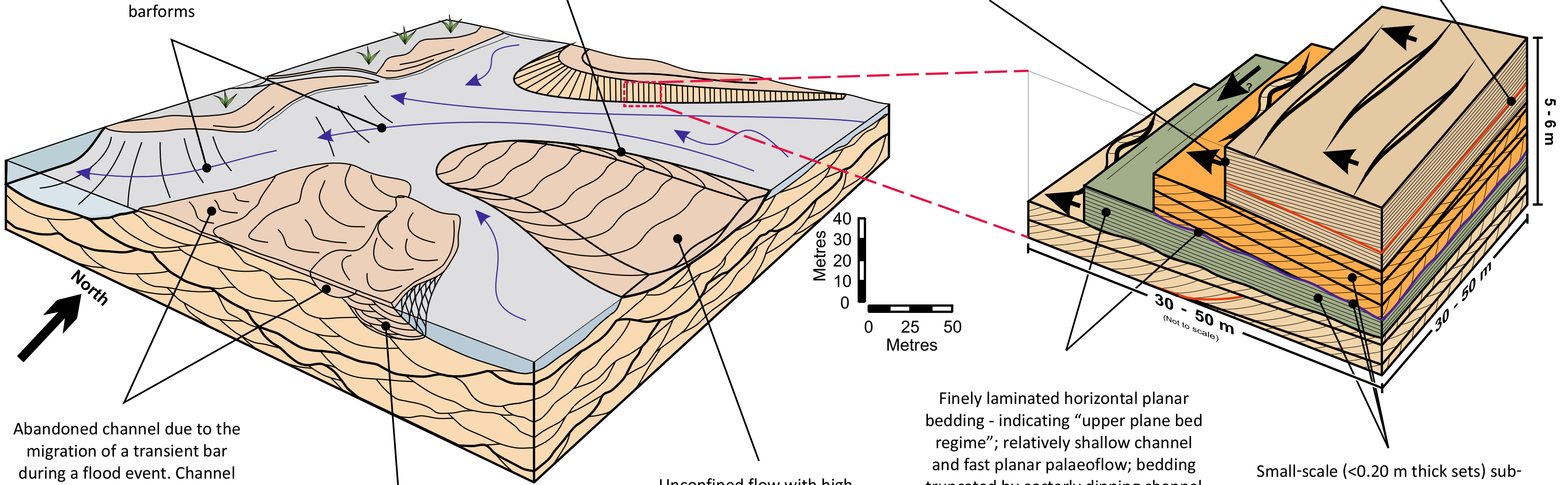
Depositional Model: Pre-flood event



Information courtesy of the Fluvial Research Group
http://frg.leeds.ac.uk/

Brimham Rocks

Depositional Model: Post-flood event



Information courtesy of the Fluvial Research Group
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