

# **Linking sill morphology to emplacement mechanisms**

by

Nick Schofield

[Supplementary maps]

A thesis submitted to  
The University of Birmingham  
For the degree of  
DOCTOR OF PHILOSOPHY

Department of Earth Sciences  
School of Geography, Earth  
And environmental sciences  
The University of  
Birmingham  
May 2009

UNIVERSITY OF  
BIRMINGHAM

**University of Birmingham Research Archive**

**e-theses repository**

This unpublished thesis/dissertation is copyright of the author and/or third parties. The intellectual property rights of the author or third parties in respect of this work are as defined by The Copyright Designs and Patents Act 1988 or as modified by any successor legislation.

Any use made of information contained in this thesis/dissertation must be in accordance with that legislation and must be properly acknowledged. Further distribution or reproduction in any format is prohibited without the permission of the copyright holder.

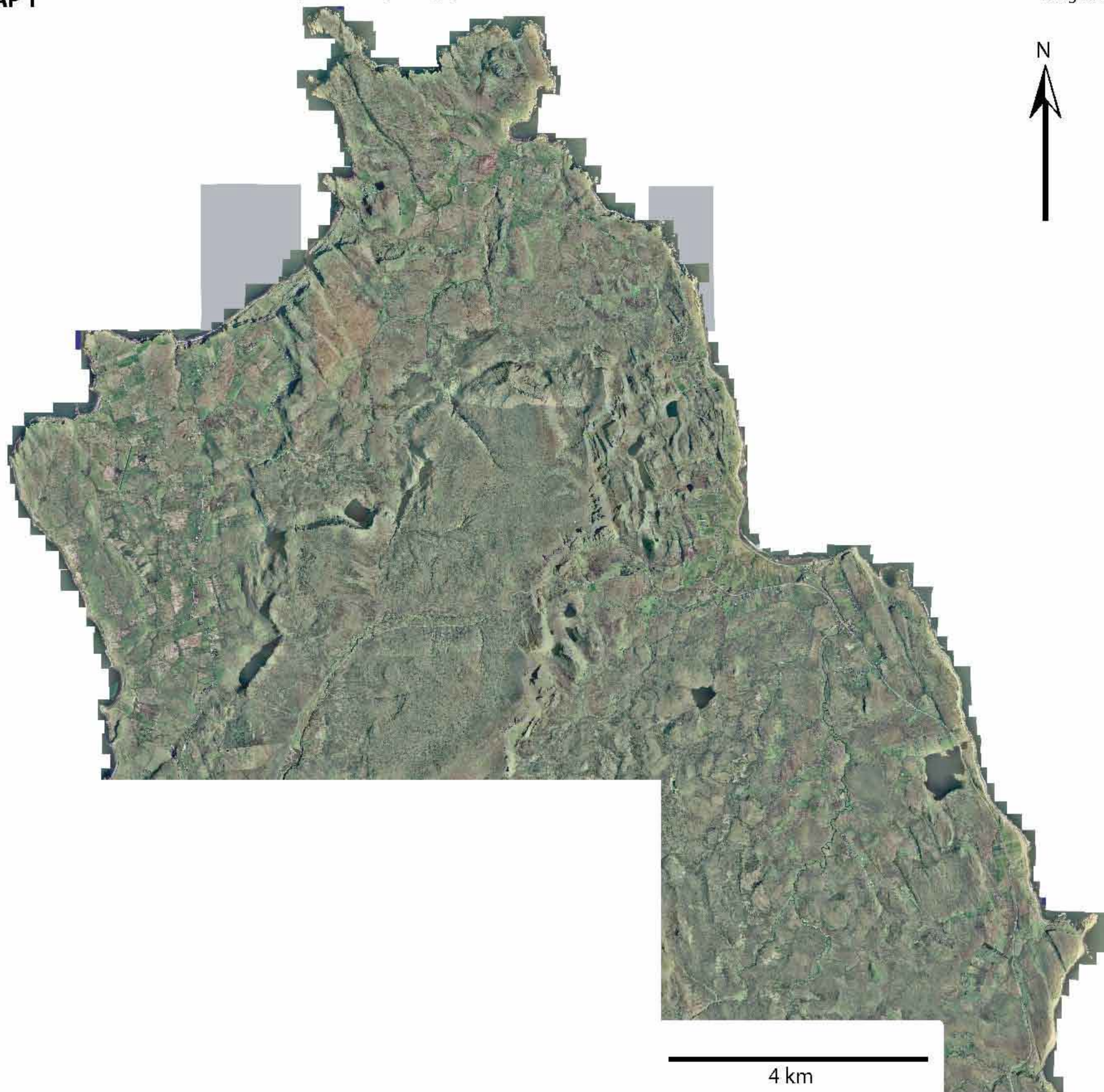
MAP 1

Composite aerial photograph of Trotternish Peninsula

NG grid square



4 km



MAP 2

Rubha Hunish

Slope Shaded DTM (bare earth)

NG grid square



75

72

69

66

63

60

Duntulm Castle

Balmacqueen

Galta Mor

Flodigarry

Rubh' a' Chairn Leith

Staffin Harbour

Kilt Rock

Lough Mealt

Valtos

Rubha nam  
Brathalrean

Invertote

5m DTM NextMap terrain data from NEODC (NERC Earth Observations Data Centre)  
Map Data © NERC 2009



4 km

MAP 3

Composite aerial photograph of Trotternish peninsula rendered with slope shaded DTM to highlight changes in slope

NG grid square



75

72

69

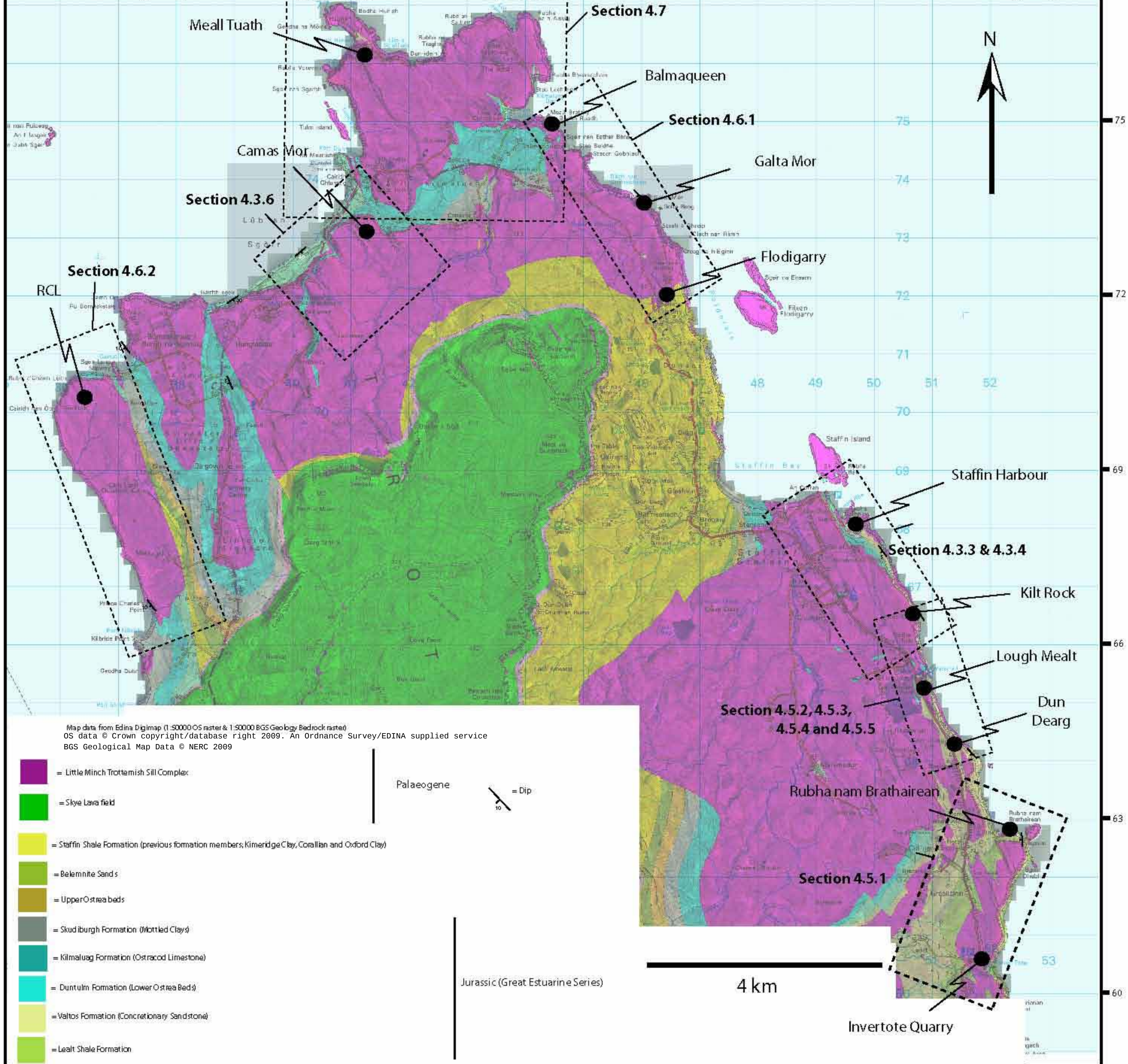
66

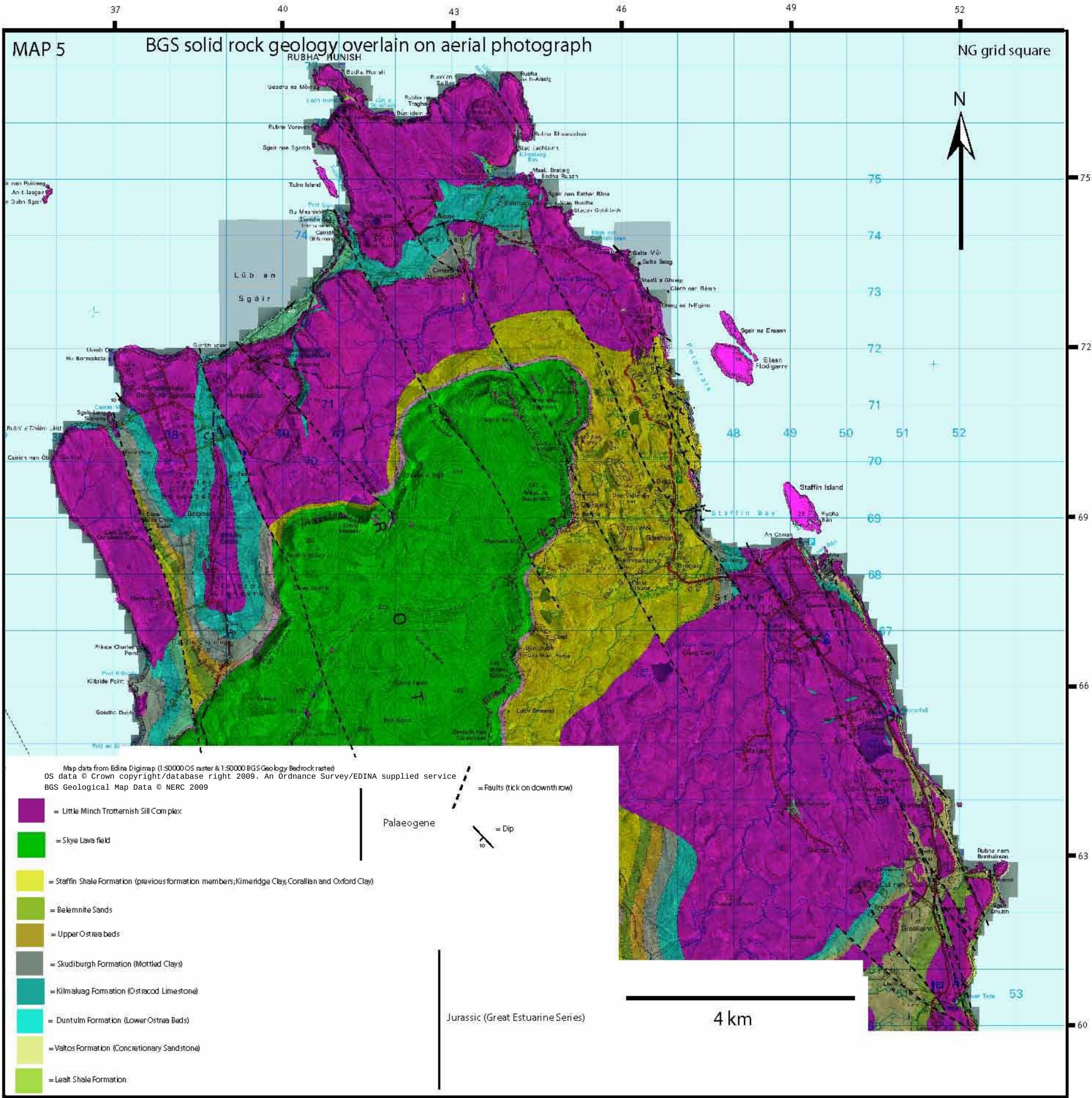
63

60

4 km

#### MAP 4 Locality Map







# Map 7

BGS solid rock geology  
& slope shaded DTM

NG grid square



Clear offset in dolerite  
and topographic  
manifestation along inferred  
fault trace

No offset or topographic manifestation visible in dolerite sheets along inferred fault trace

Sharp change in slope and continuation with topographic  
features extending away from cliffs suggests  
bedrock is dolerite and not Jurassic sedimentary strata

No clear offsets or topographic manifestation in dolerite  
sheet along inferred fault trace

No apparent offset in dolerite sheet visible  
inland along inferred trace of fault

Clear topographic manifestation  
along inferred fault traces

Map data from Edina Digimap (1:50000 OS raster & 1:50000 BGS Geology Bedrock raster)  
OS data © Crown copyright/database right 2009. An Ordnance Survey/EDINA supplied service  
BGS Geological Map Data © NERC 2009

- = Little Minch Trotternish Sill Complex
- = Skye Lava field
- = Staffin Shale Formation (previous formation members; Kimeridge Clay, Corallian and Oxford Clay)
- = Belemnite Sands
- = Upper Ostrea beds
- = Skudiburgh Formation (Mottled Clays)
- = Kilmaluag Formation (Ostracod Limestone)
- = Duntulim Formation (Lower Ostrea Beds)
- = Valtos Formation (Concretionary Sandstone)
- = Lealt Shale Formation

Palaeogene

= Faults (tick on downthrow)

= Dip

10

Jurassic (Great Estuarine Series)

4 km

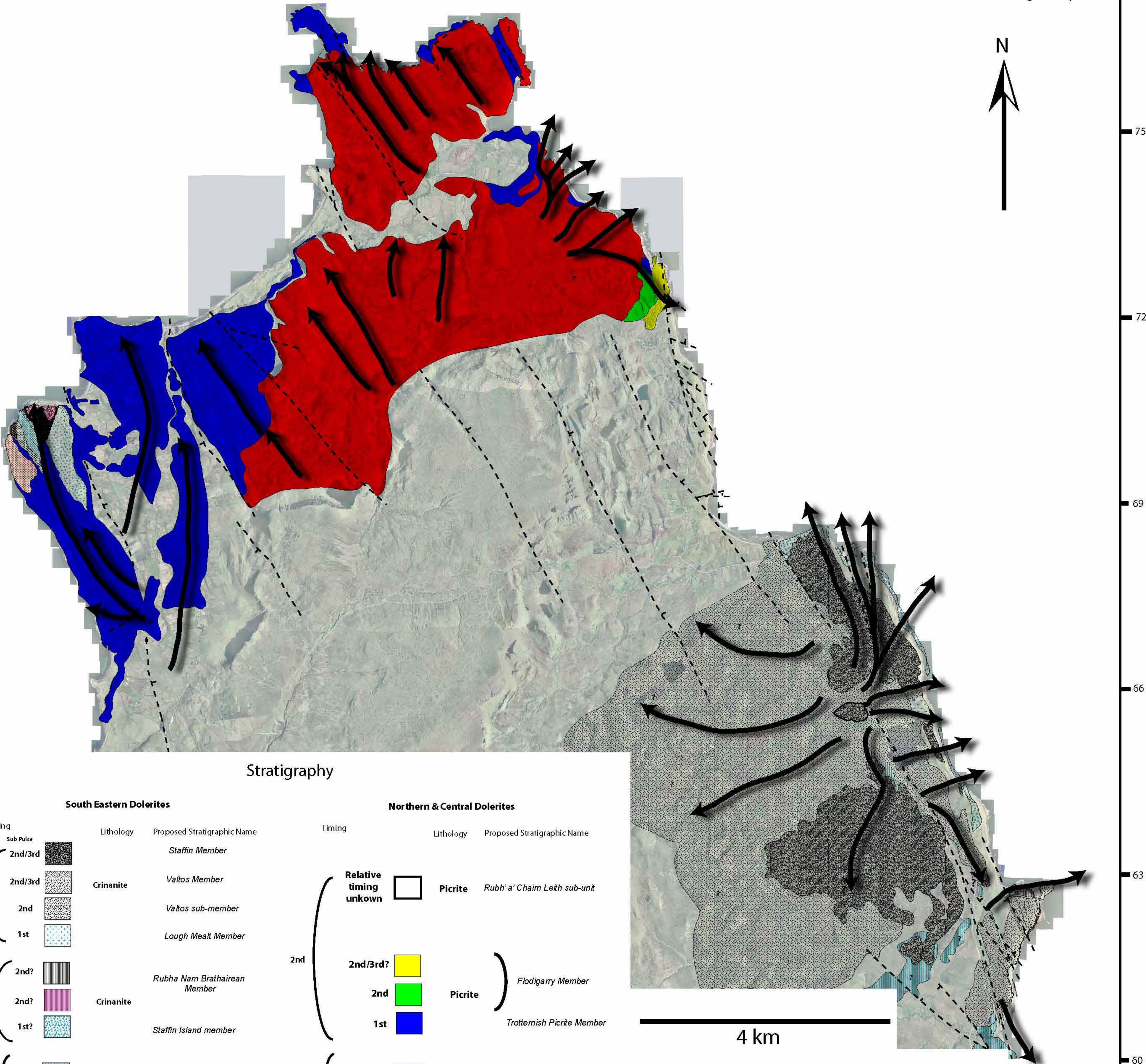


MAP 9

Inferred flow directions of Trotternish/Little Minch Sill Complex

NG grid square

N



Stratigraphy

South Eastern Dolerites

Northern & Central Dolerites

| Timing     |           |  | Lithology | Proposed Stratigraphic Name  | Timing                  |          |           | Lithology                     | Proposed Stratigraphic Name |
|------------|-----------|--|-----------|------------------------------|-------------------------|----------|-----------|-------------------------------|-----------------------------|
| Main Pulse | Sub Pulse |  |           |                              |                         |          |           |                               |                             |
| 3rd        | 2nd/3rd   |  | Crinanite | Staffin Member               | Relative timing unknown |          | Picrite   | Rubh' a' Chaim Leith sub-unit |                             |
|            | 2nd/3rd   |  |           | Valtos Member                |                         |          |           |                               |                             |
|            | 2nd       |  |           | Valtos sub-member            |                         |          |           |                               |                             |
|            | 1st       |  |           | Lough Mealt Member           |                         |          |           |                               |                             |
| 2nd        | 2nd?      |  | Crinanite | Rubha Nam Brathairean Member | 2nd                     | 2nd/3rd? | Picrite   | Flodigarry Member             |                             |
|            | 2nd?      |  |           | Staffin Island member        |                         | 2nd      |           | Trotternish Picrite Member    |                             |
|            | 1st?      |  |           |                              |                         | 1st      |           |                               |                             |
| 1st        |           |  | Picrite   | South Eastern Picrite Member | 1st                     |          | Crinanite | Northern Crinanite Member     |                             |

Pullout 1

Invertote and Rub nam Brathairean

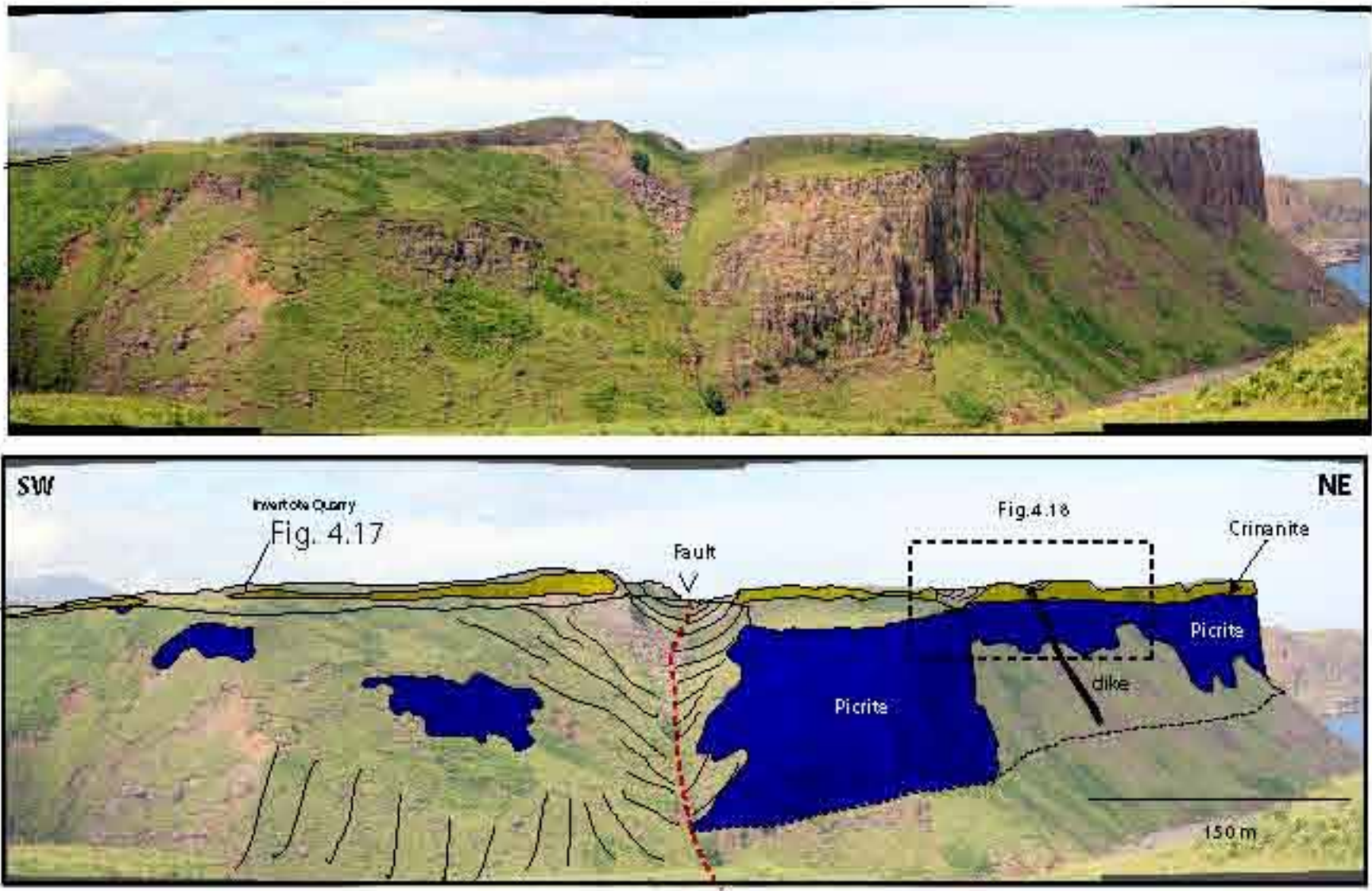


Fig. P1.1 - Cliff section at Invertote showing crinanite and picrite units (crinanite post dates picrite)

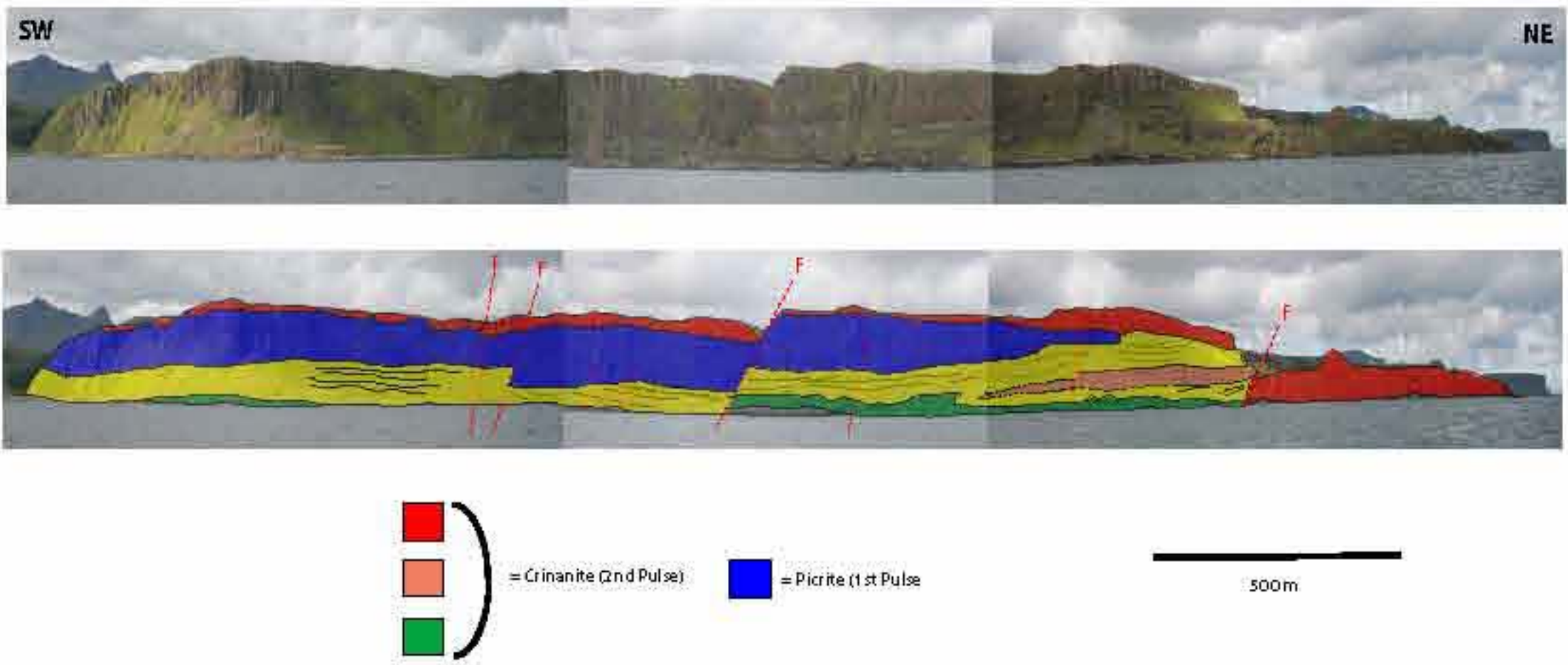


Fig. P1.2 – Cliff section and interpretation of Invertote to Rum nam Brathairean

Dun Dearg, Lough Mealt and Kilt Rock

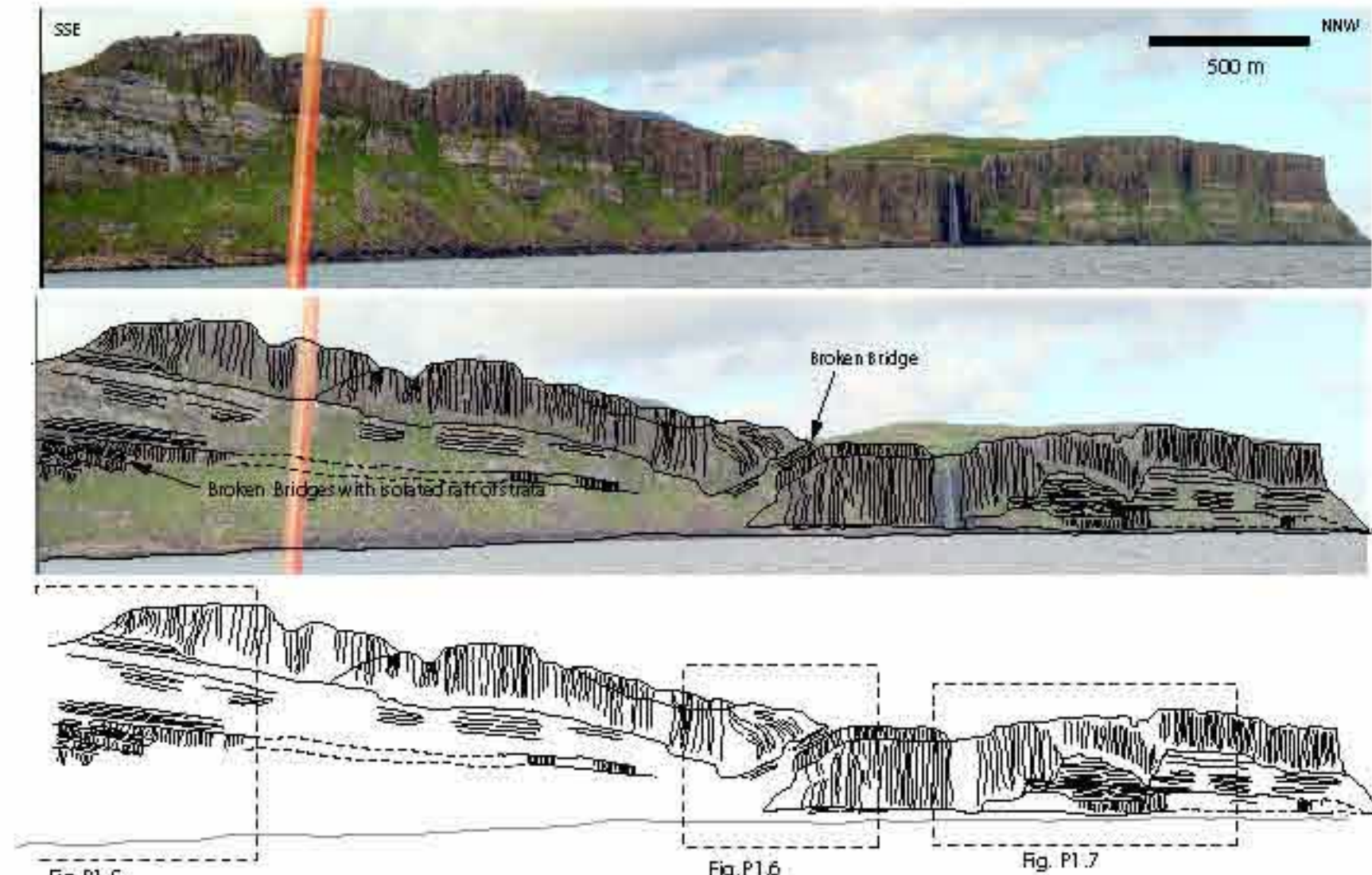


Fig. P1.3 – Dun Dearg, Lough Mealt and Kilt rock coastal section showing general sill form. Note the general open syndinal nature of the dolerite in the upper tier of the cliff face, and occurrence of a large scale broken bridge structure in the diff face. Locations of other figures are marked.

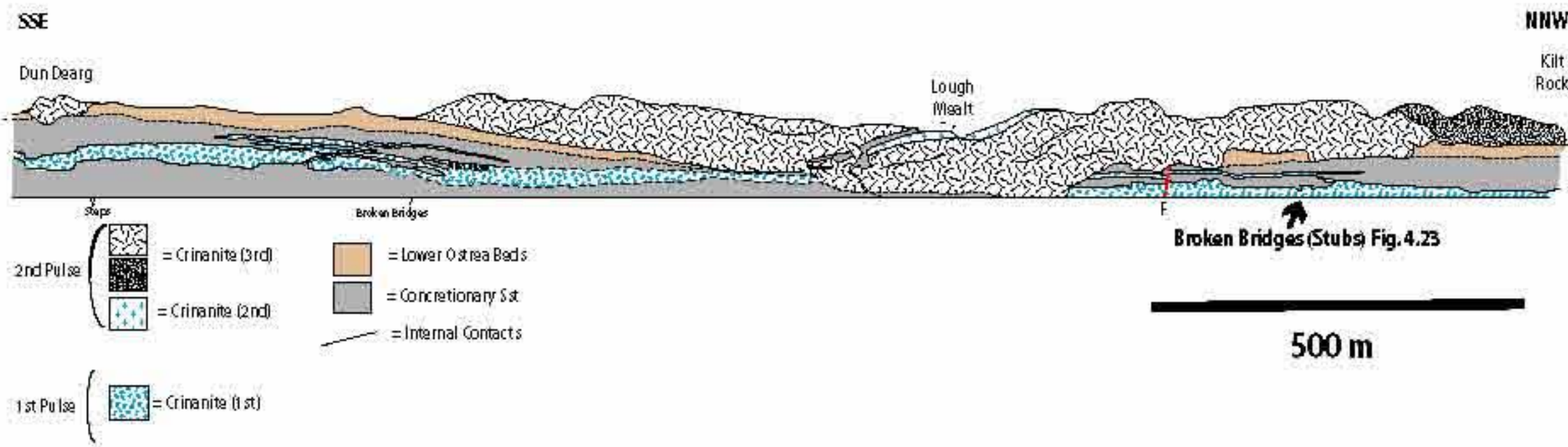


Fig. P1.4 - Sketch cross-section showing structure of Dun Dearg to Kilt Rock. Note the first main pulse of crinanite forming the lower tier of sills which is cross-cut by the 2nd main pulse of crinanite in the region of Lough Mealt.

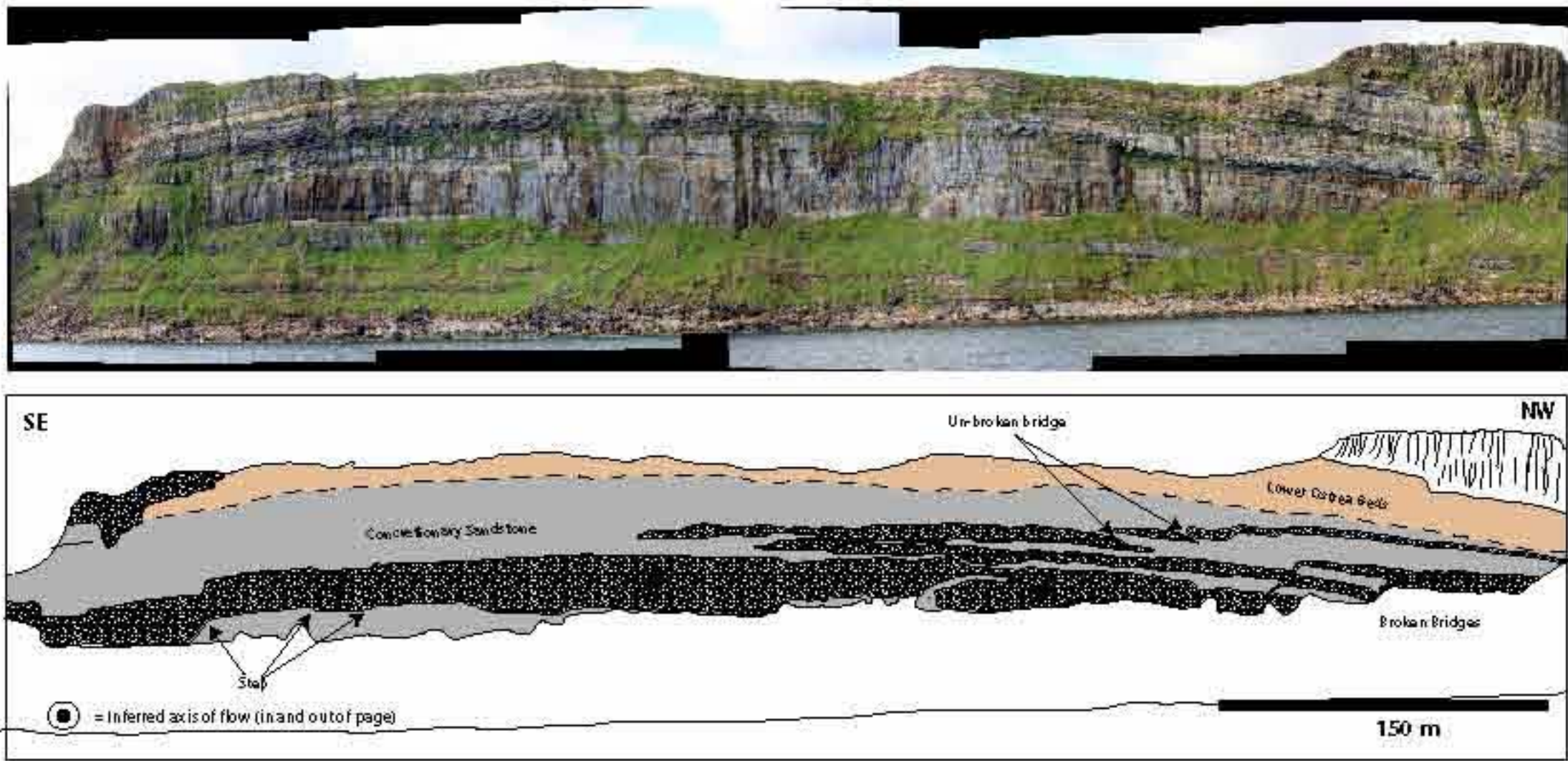


Fig. P1.5 - Dun Dearg cliff section showing sill intrusions into cliff and occurrence of steps, un-broken and broken bridges.

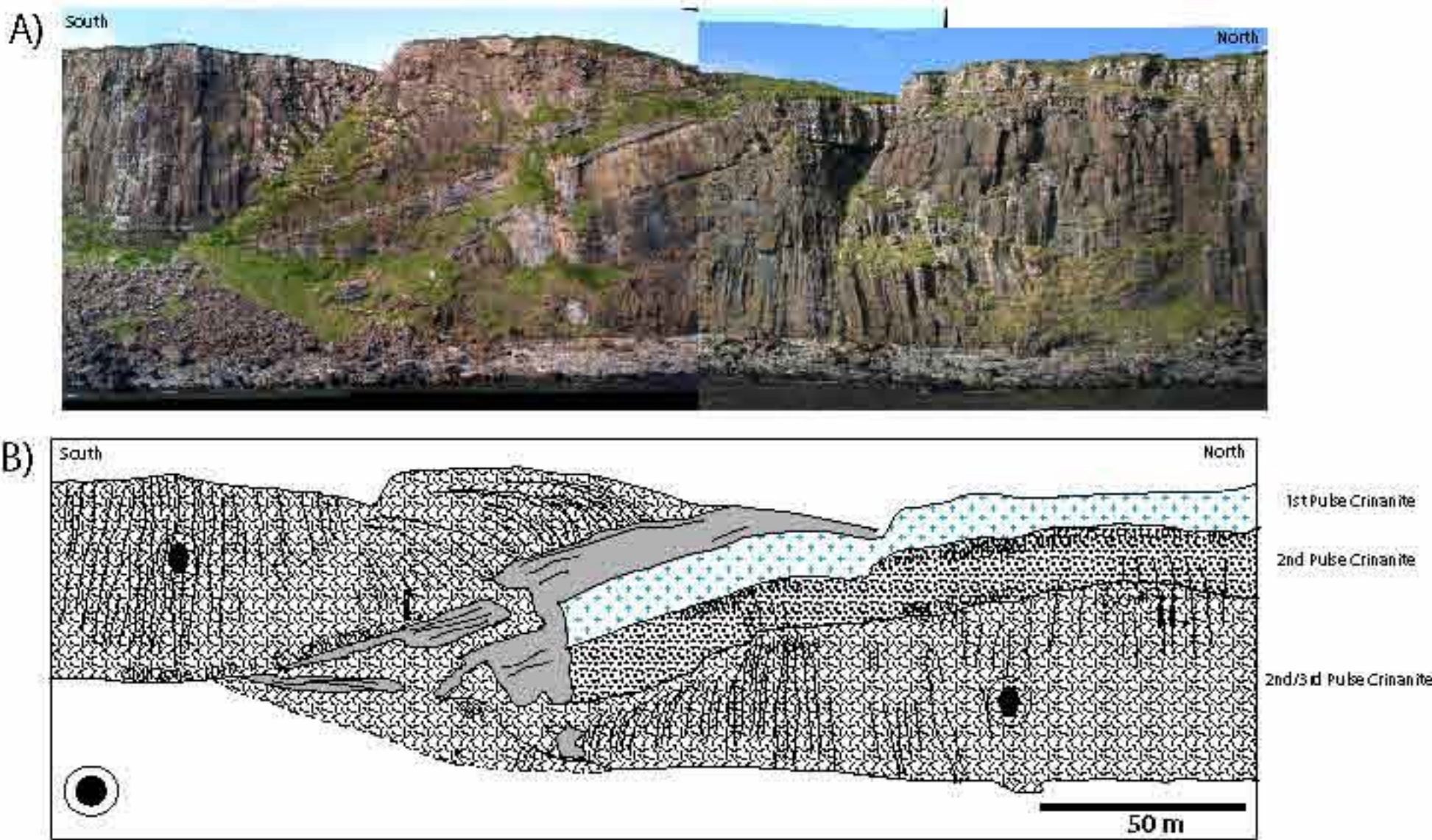


Fig. P1.6 - Broken bridge structure at Lough Mealt (i) caused by the inflation of two separate offset sill segments. The lower tier of dolerite appears to have inflated by a series of sub-pulses. The chronology of the sub-pulses can be deduced from one another by the presence of internal dikes within the sheet (ii).

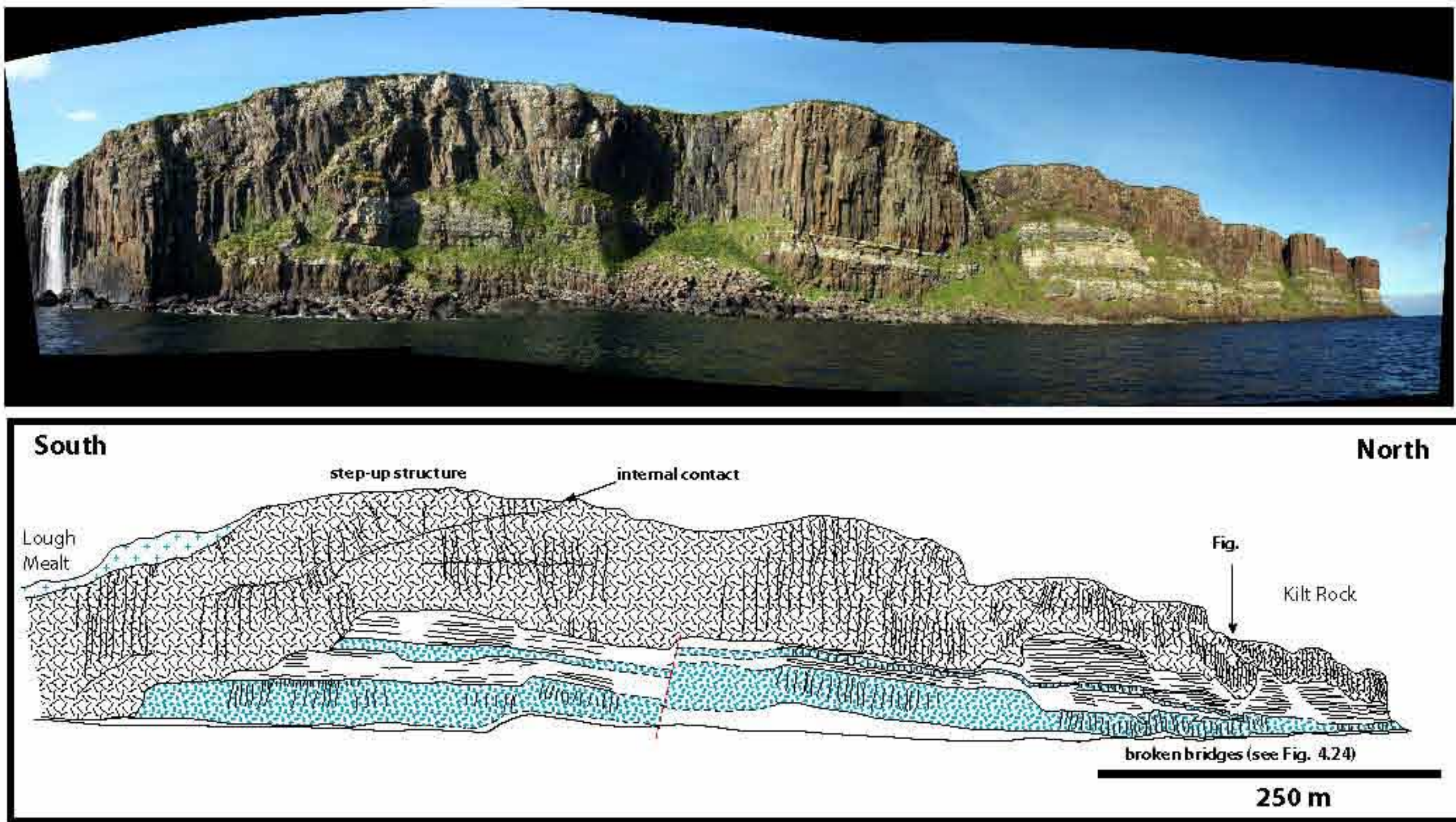


Fig. P1.7 – Sill structure north of Lough Mealt showing the upper tier dolerite cross-cutting the lower tier dolerite and stepping up stratigraphy. The lower tier dolerite is cut by a fault which does not appear to offset the upper tier dolerite. This suggests that faulting was taking place between intrusion events. Internal contacts can be seen within the upper tier dolerite, suggesting that it amalgamated from separate sub-pulses.

Pullout 2

Galta Mor (Flodigarry - Balmaqueen)

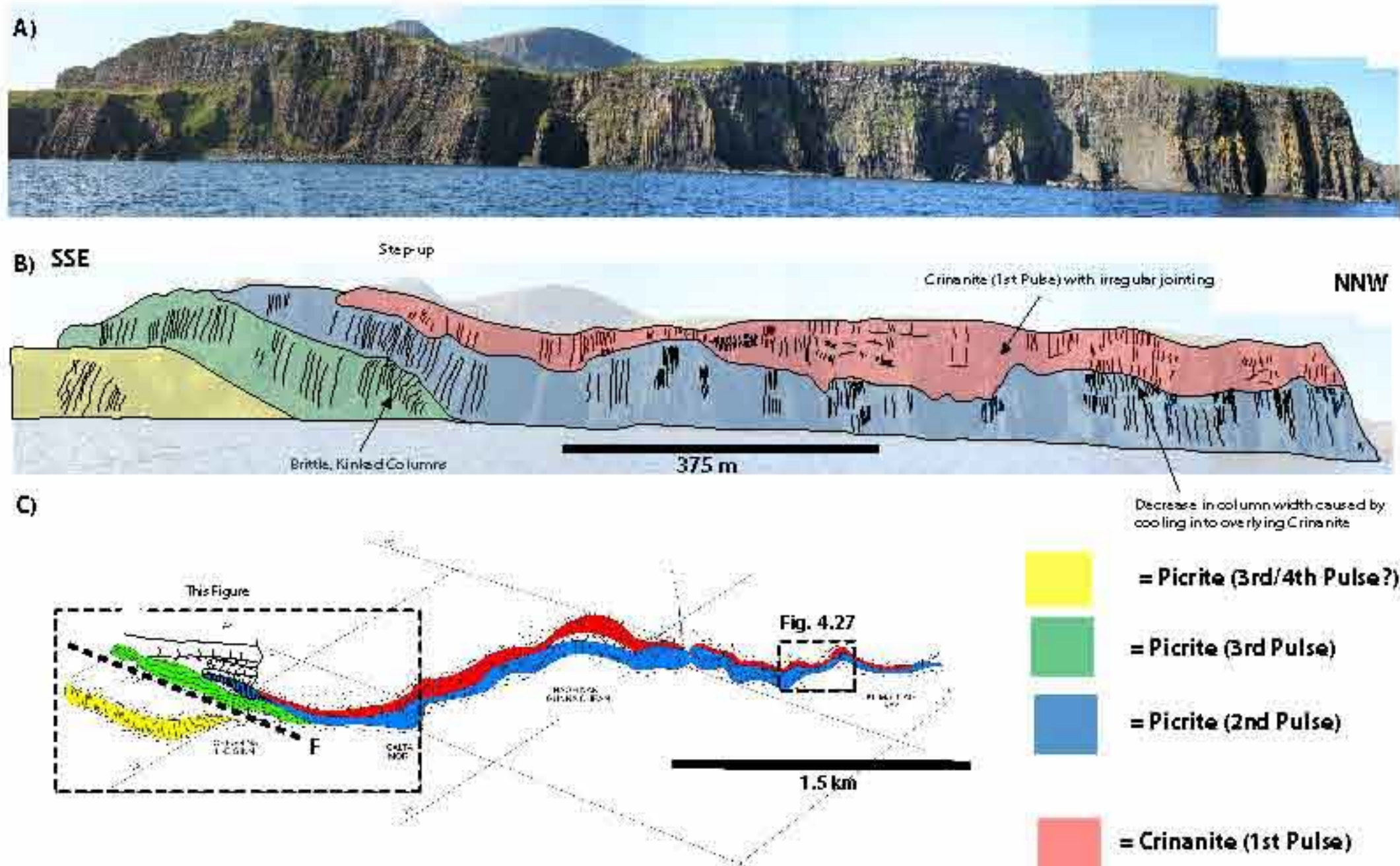


Fig. P2.1 – (a) Galta mor coastal section and (b) interpretation. (c) Overall sill structure from Flodigarry to Balmaqueen, showing crinanite overlying picrite (picrite post-dates crinanite). Figure C redrawn and modified from Hutton & Owens (unpublished report).

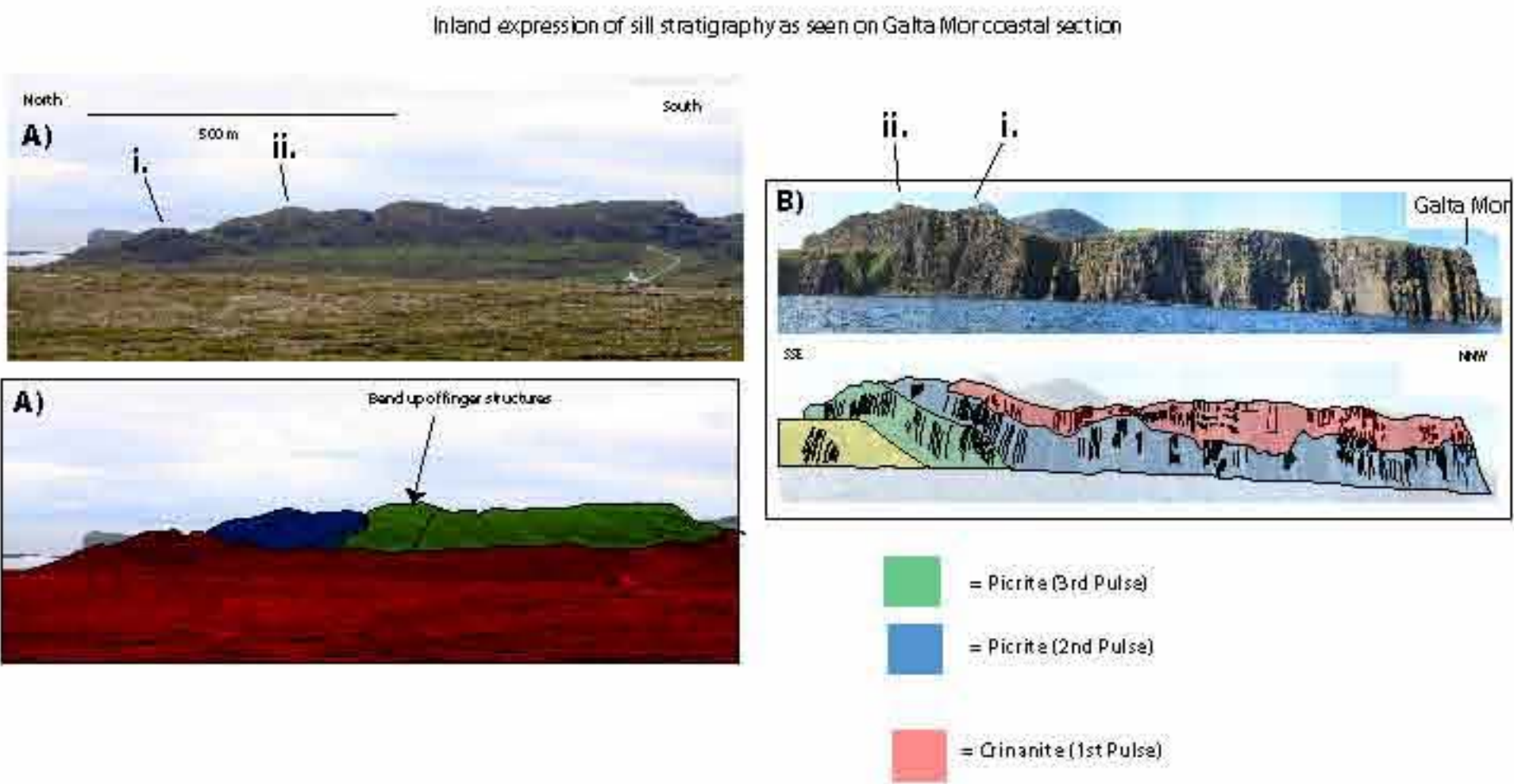


Fig. P2.2 – Sill stratigraphy seen on coastal section traced by changes in slope inland. Points i. and ii. represent the same features in diagram A and B.

Rubha'a'chairn Leith (RCL)

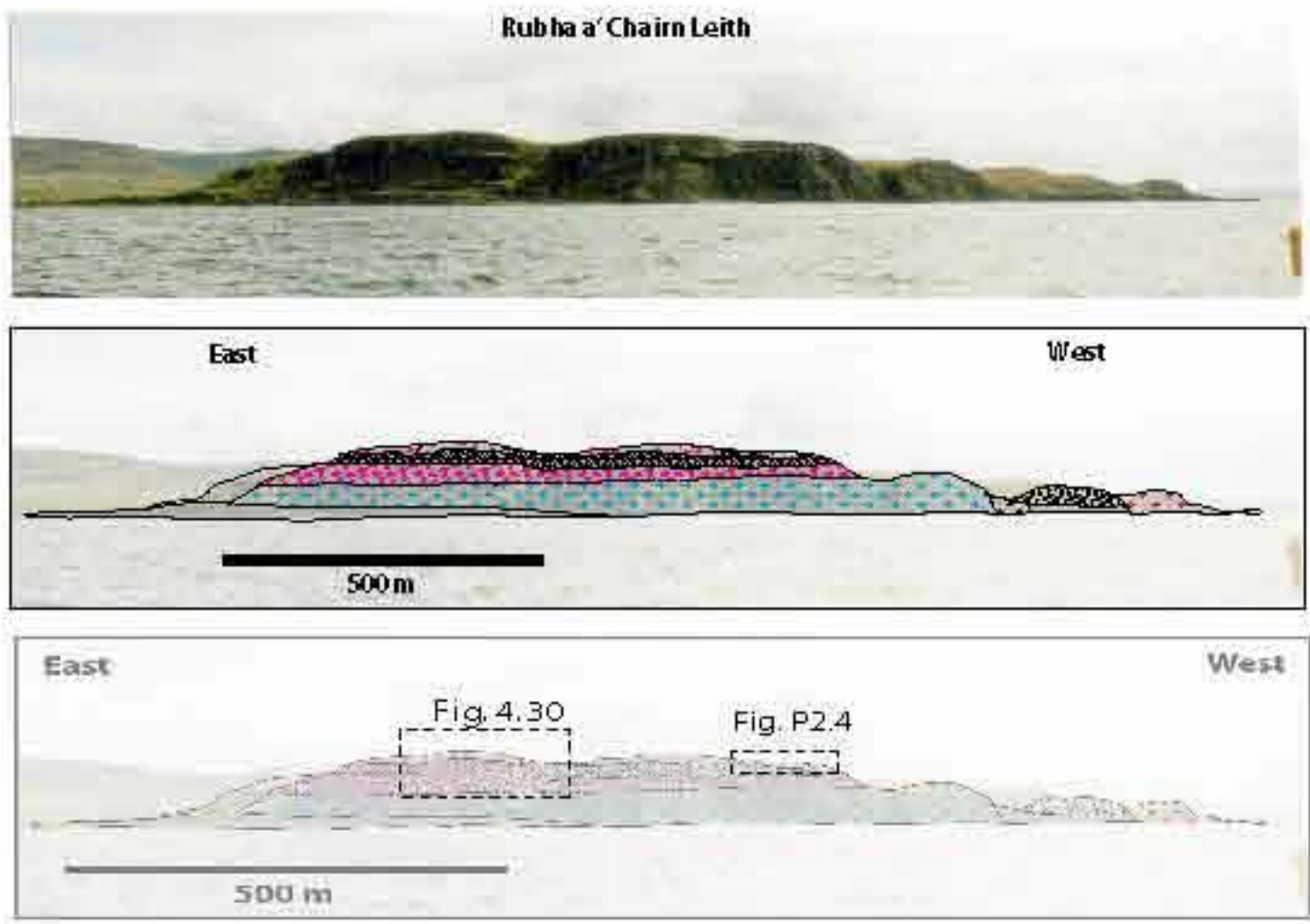


Fig. P2.3 – Coastal section of Rubha'a' chairn Leith (RCL), showing internal contacts between different picrite units visible within the cliff face. Photo courtesy of Donny Hutton

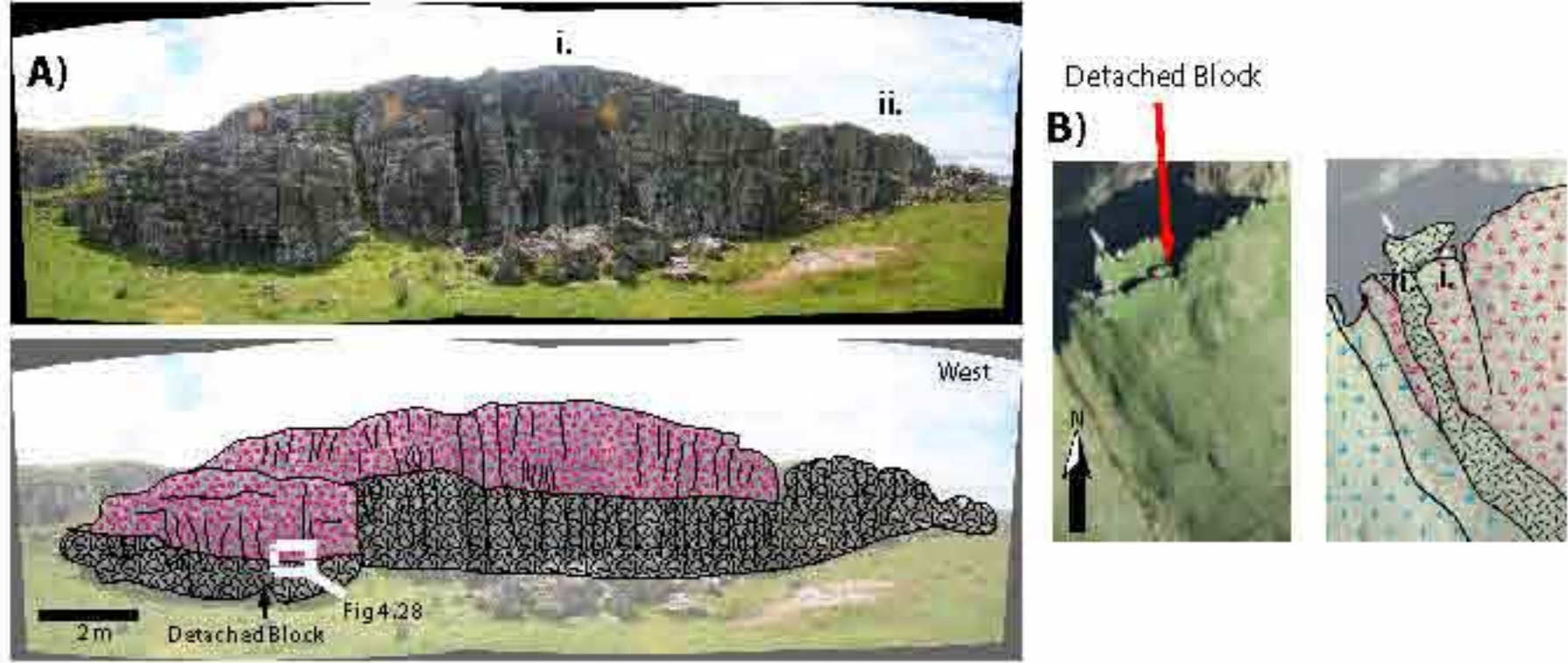
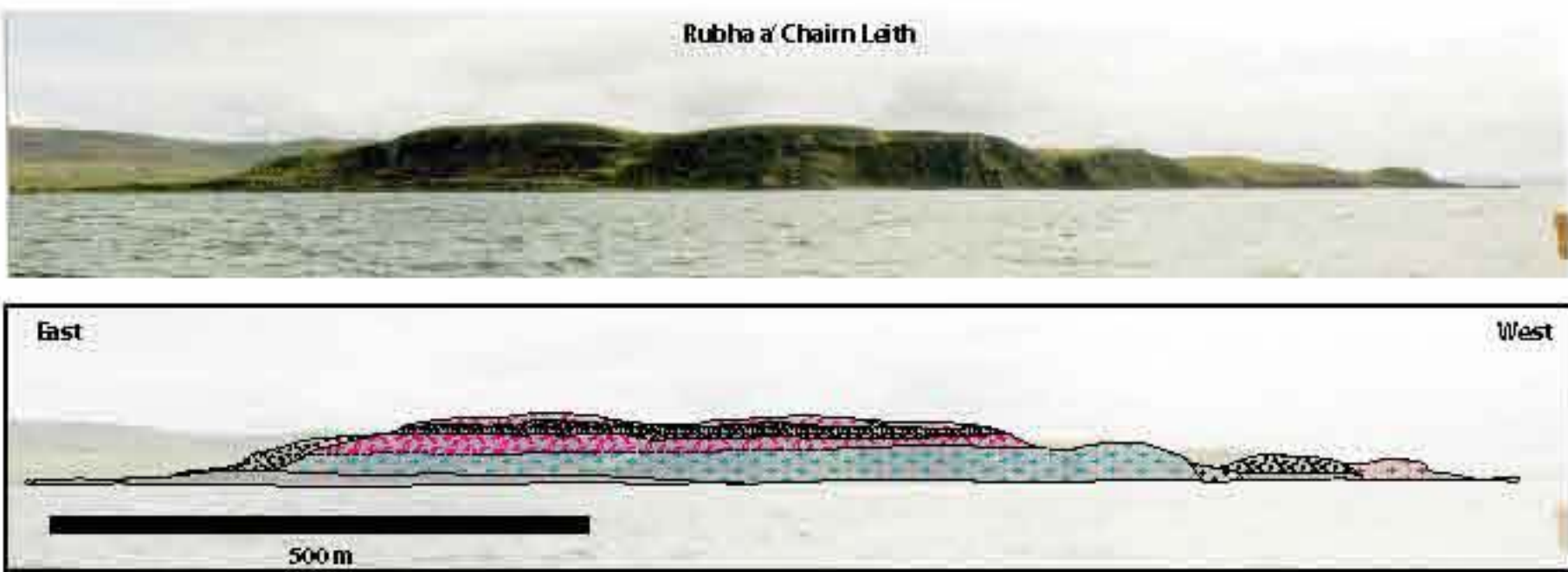


Fig. P2.5 – Flow units of Rubha'a' chairn Leith mapped inland from coastal section by changes in slope.

Northern Section

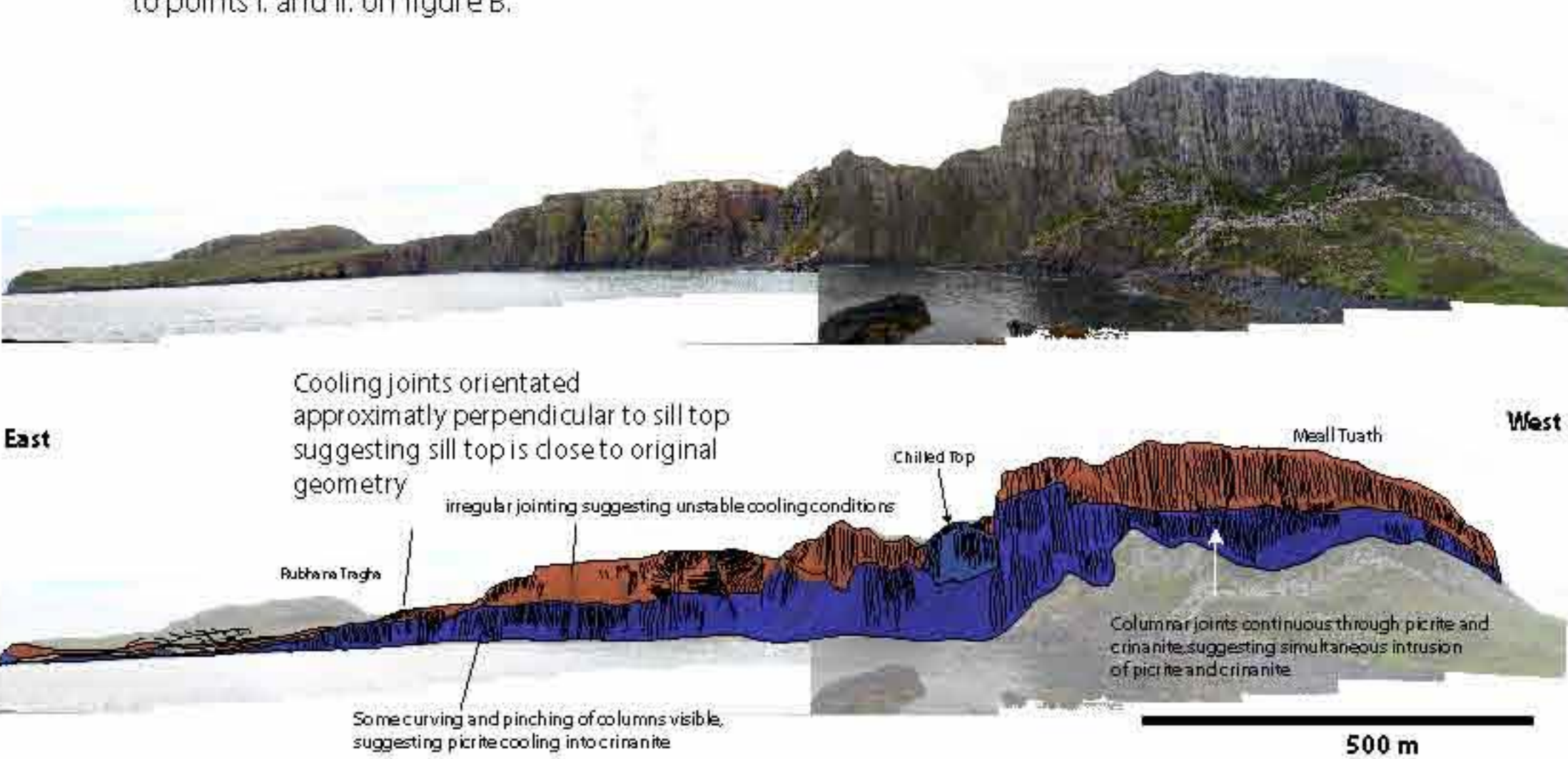


Fig. P2.6 – Sill structure of the northern dolerite sheet exposed in the northern most part of the Trotternish Peninsula. Note the pervasive nature of cooling joints through both crinanite and picrite units.

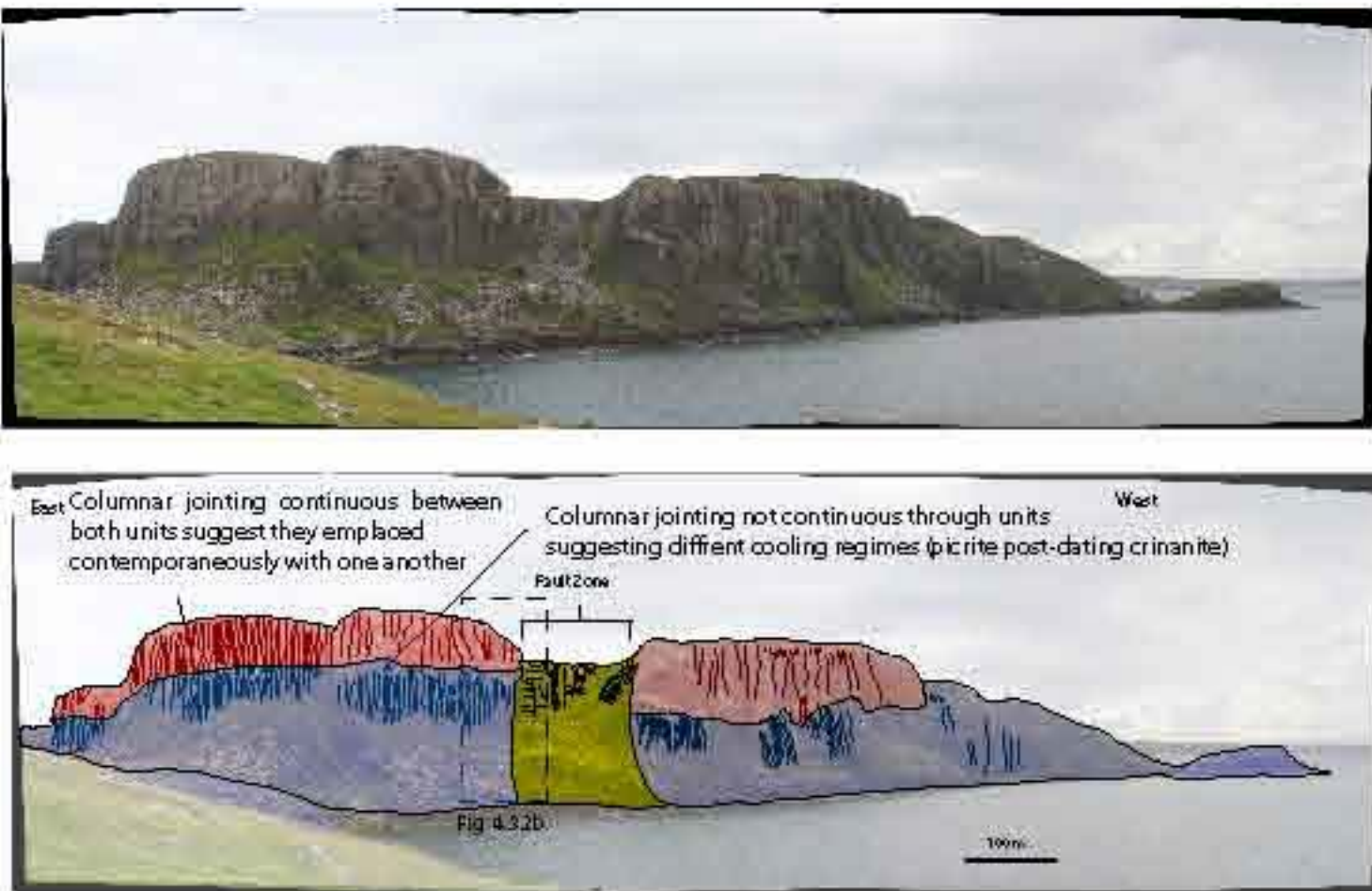


Fig. P2.7 – Fault zone cutting Meall Tuath. The fault post-dates the intrusion of the sills. Point I. marked for orientation on Map pulouts.

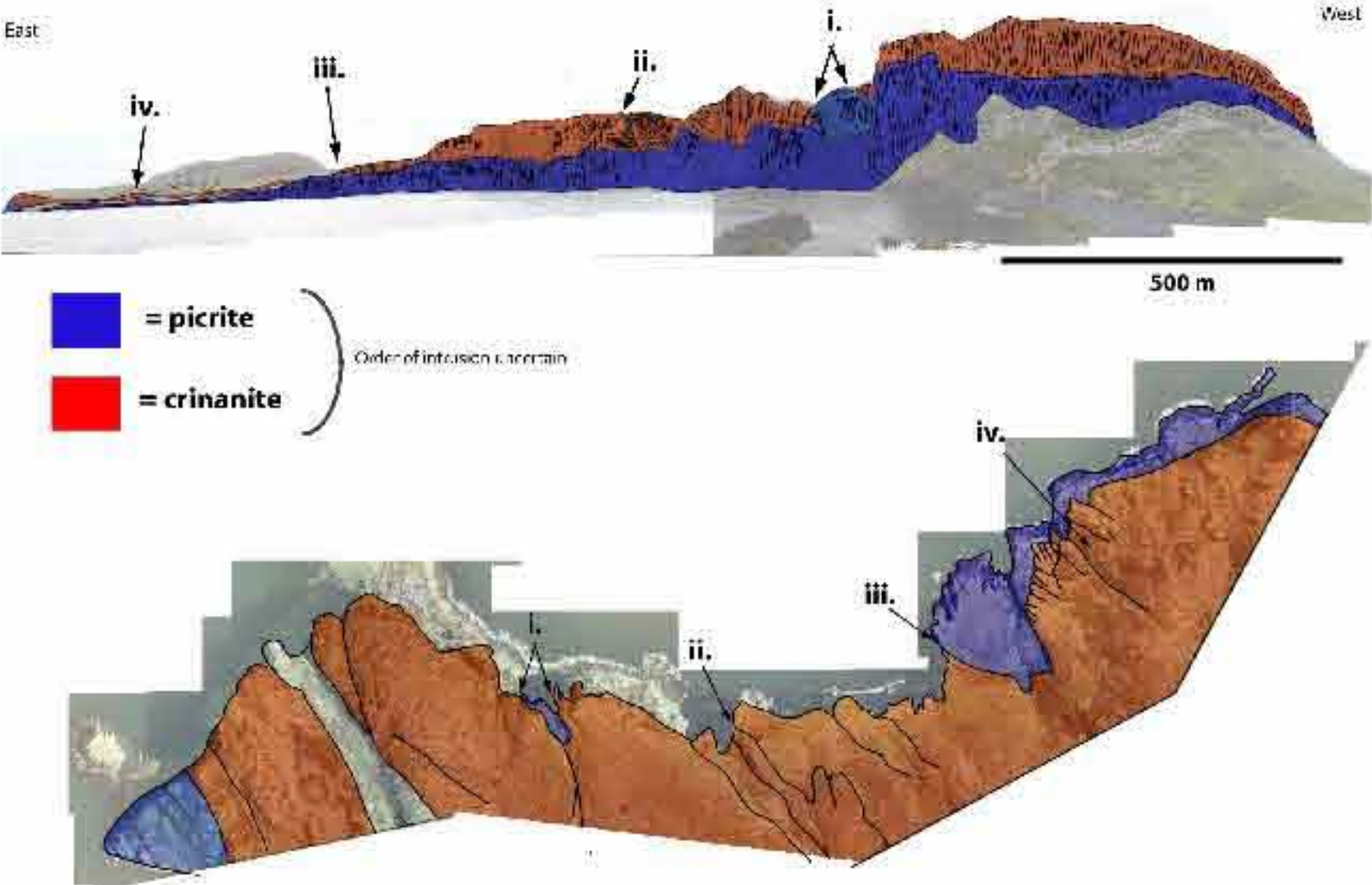


Fig. P2.8 – Expression of sill stratigraphy seen on coastal cliff section (top) mapped inland by changes in slope. Solid black lines represent prominent landform features. Points i. - iv. represent features on cliff section easily traced in land by topographic expression. Point I.V. defines finger like features ~ 25 - 30m in width which can be traced in land.