

Modern applications for basin-wide revision mapping in the Old Red Sandstone, Scotland

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1. Project background

The **Strathmore Basin** (Midland Valley of Scotland, UK) is an extensive Silurian-Devonian basin of sedimentary and volcanic rocks with a long tectonic history. It is bound by the Highland Boundary Fault to the north, and folded into the NE-SW trending Strathmore Syncline and Sidlaw Anticline. Carboniferous strata overlie to the south.

The current 1:50 000 scale **geological map** (Fig. 1, centre page) was mapped "sheet by sheet" between the 1880's - 1990's (Fig. 1.1); beginning before regular use of aerial photography, and nearly a century before the theory of plate tectonics. This has led to mismatches at paper map boundaries (Fig. 1. A & B), inconsistencies in structural interpretation (Fig. 1. C), and irregularities in stratigraphic relationships (Fig. 1. D & E). Addressing these legacy issues is critical for ensuring our geological maps are consistent and fit-for-purpose for 21st century applications.

A new **basin-wide approach to revision mapping** (Section 2) has been taken to improve map quality and consistency across the basin. This has involved:

- Compilation of basin-wide structural (Fig. 2.1) and lithological datasets (Fig. 2.2) (Section 2)
- Targeted fieldwork (Section 2)
- Structural review of historical, field, and terrain data (Section 3)
- Sedimentological and stratigraphic review (Section 4)

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2. A Novel Basin-wide Mapping Method

Structural data capture and digital terrain analysis

- Lineament analyses at several map scales and comparison to mapped fault patterns
- 4,103 structural data points captured from legacy field maps (Fig. 2.1)
- 508 further structural readings from targeted fieldwork

Used to revise basin-scale structural model (Section 3), inform the revision of basin-crossing faults, and to help define target areas for fieldwork

Lithological data capture

- 20,671 aggregated lithological data points (Fig. 2.2) from:
- Historical map observation points
- Quarry and pit commodities
- Rock sample locations
- Borehole records

Targeted fieldwork and data capture with CRAG

Limits of legacy data - original mapping pre-plate tectonic theory, focused on resources (e.g. building stones), not structure

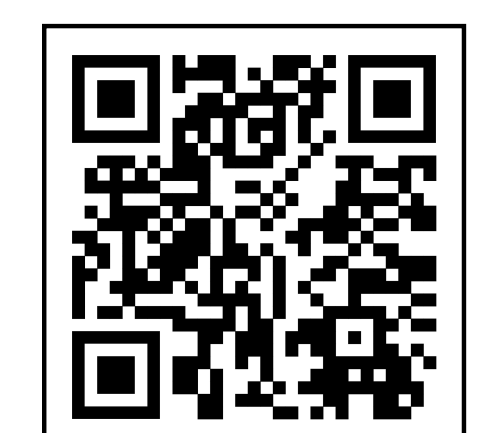
- Field descriptions, while consistent, were less detailed (space-limited)

Areas identified for targeted fieldwork focused on areas of stratigraphic, lithological, or structural problems in the digital map

Fieldwork carried out using newly-developed open source BGS QGIS plugin **CRAG - Capture and Reporting of Associated Geodata**

Coming soon to [GitHub](#) and [QGIS plugins repository](#)!

More about CRAG:



Stevenson et al., 2025



3. Structural review: fault systems and basin geometry

Lineament analysis: linear features (picked from the DTM analysis) show different dominant trends and lengths compared to those on the 1:50 000 scale map (Fig. 3.1)

- Several faults do not show topographic expression in the DTM (Fig. 5.2)

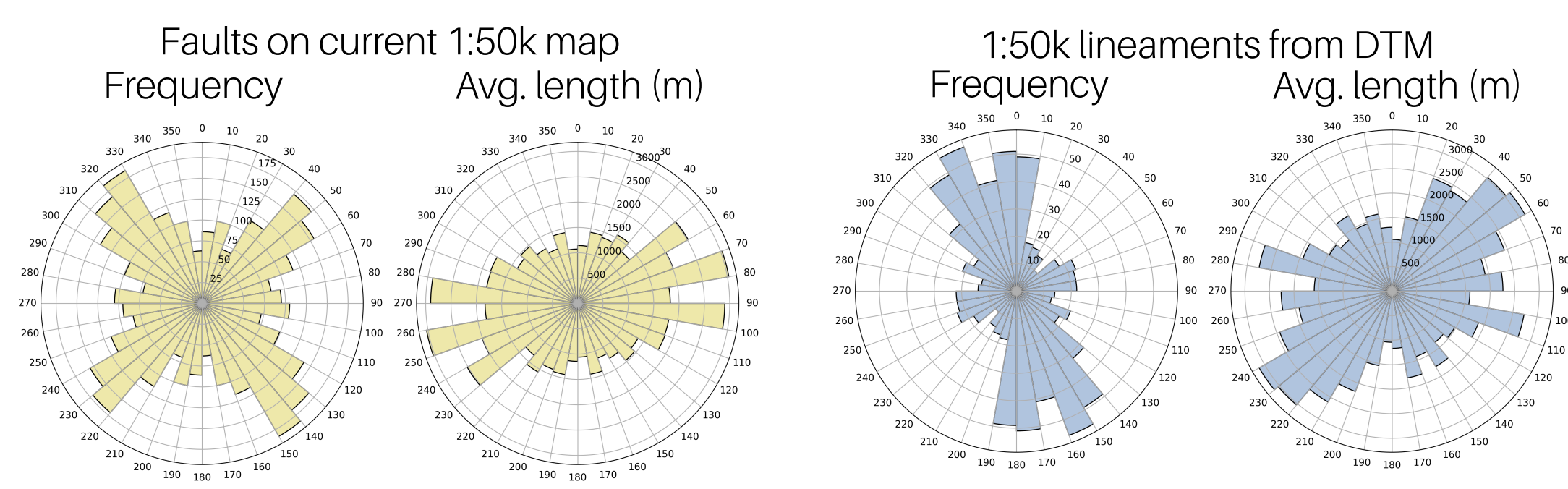


Figure 3.1

Fold geometry generally considered as cylindrical syncline-anticline, parallel to Highland Boundary Fault (Fig. 3.2 A)

Point data analysis suggests non-cylindrical fold geometry and multiple possible fold closures along length of basin (Fig. 3.2 B) (Stephens et al., 2026)

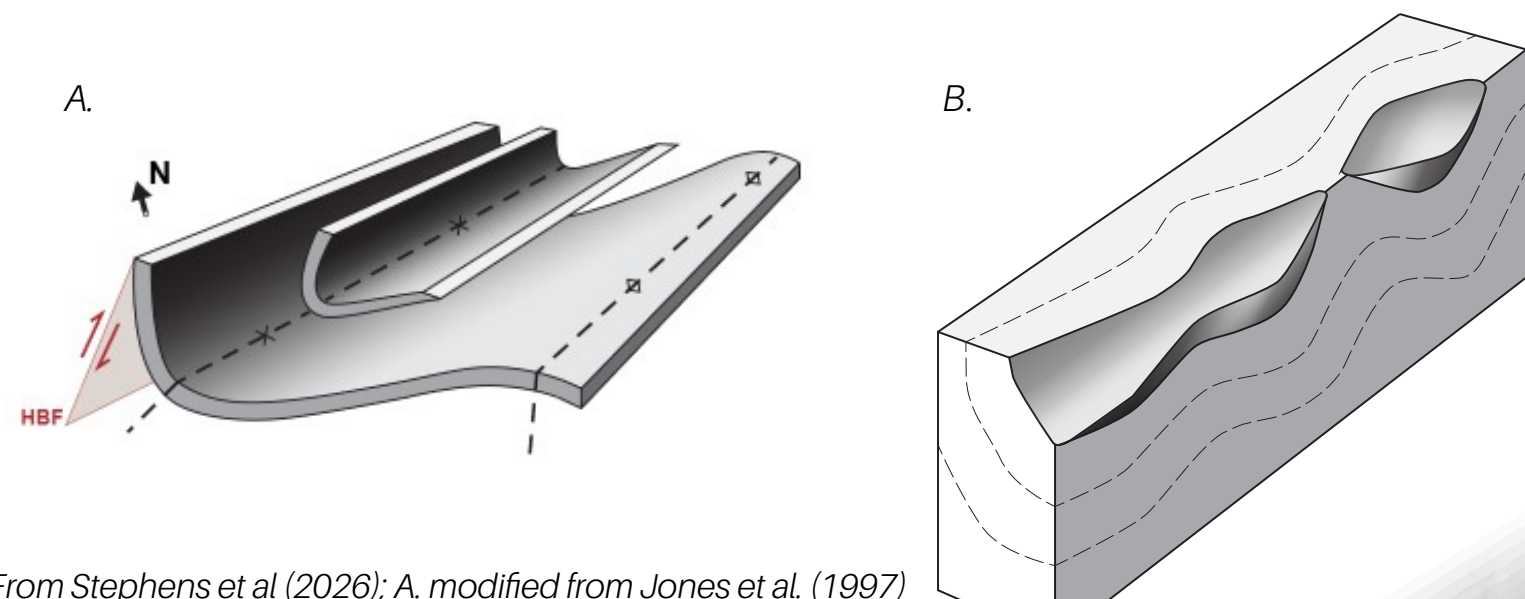


Figure 3.2

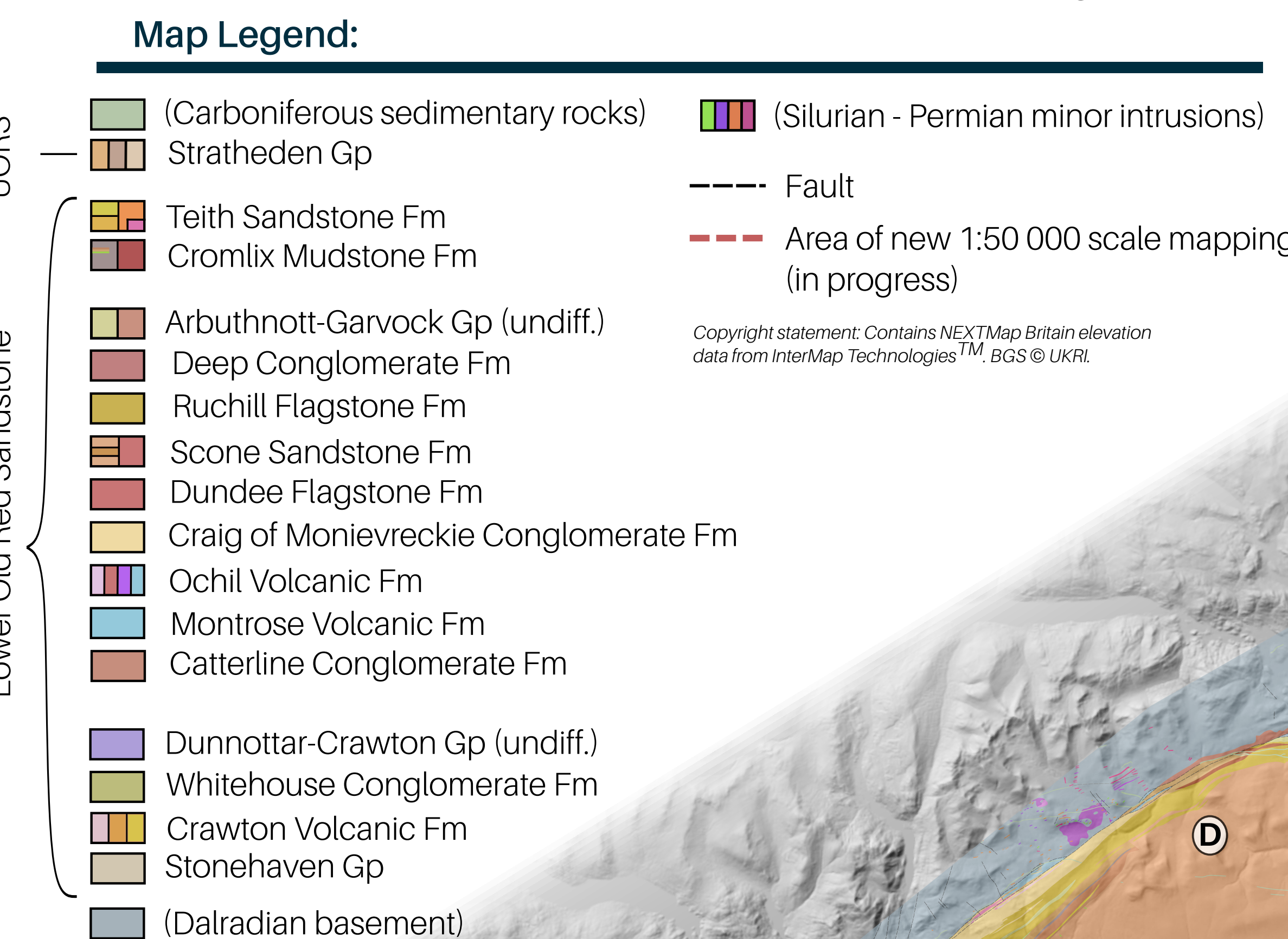


Figure 1. Current BGS 1:50 000 scale bedrock map (pre-revision). Various "sheet-boundary" issues are listed (A-F). Location of Fig. 5.2 shown at location F.

5. Insights from "Regional Resurvey"-style Mapping

Challenges:

Limited exposure - thick Quaternary deposits cover most of the basin; bedrock outcrop often limited to stream sections (Fig. 5.1)

- faults often eroded or covered by superficial material

Limited subsurface data - no usable seismic data, and no boreholes that penetrate base of Devonian

Limited resources - not all areas can be revisited! Requires prioritisation of key map issues

Outstanding Questions:

Geochronology - possibility for inter-formational unconformities (Fig. 4.2)? Timing relationships between volcanic units?

Buried geology - faults and stratigraphic architecture of basin are unconstrained at depth

Revision mapping: large-scale improvements from remote observations and targeted field surveys

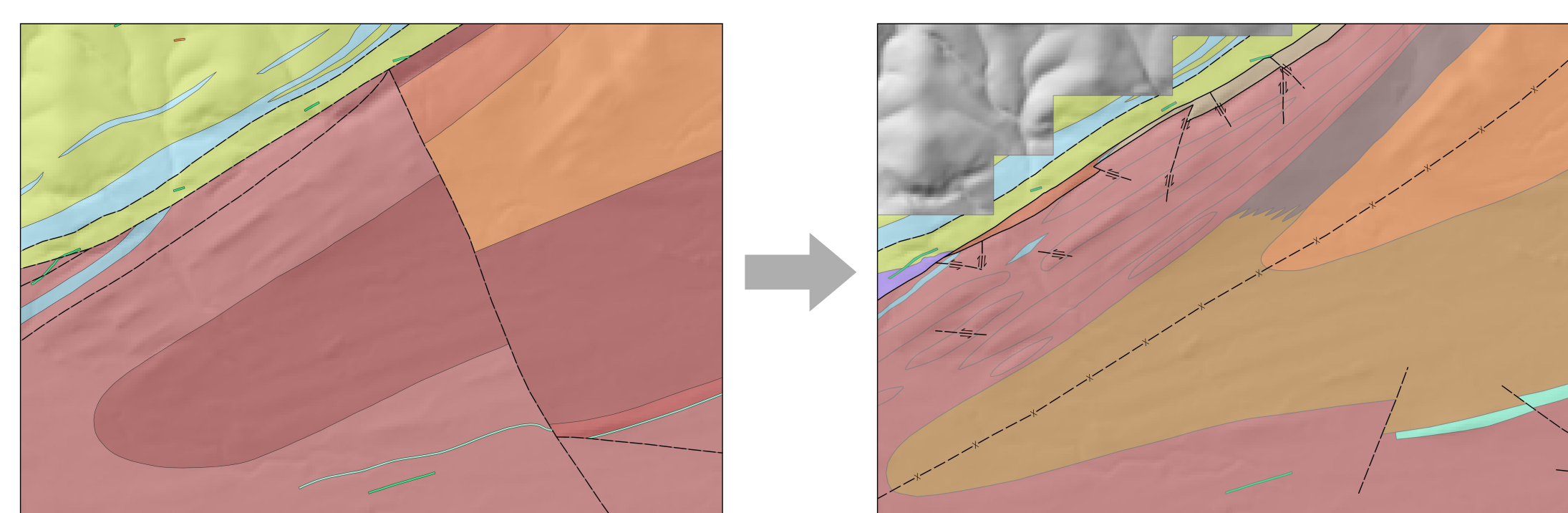


Figure 5.2. Current 1:50 000 scale map and comparison to revised map (draft); see Fig. 1. F for location.

4. Stratigraphic review: marker horizons as "anchor points" for map revisions?

Stratigraphic correlation is complicated by limited marker horizons and ambiguity over their extent, lithology, and age. Current stratigraphic framework in Fig. 4.1:

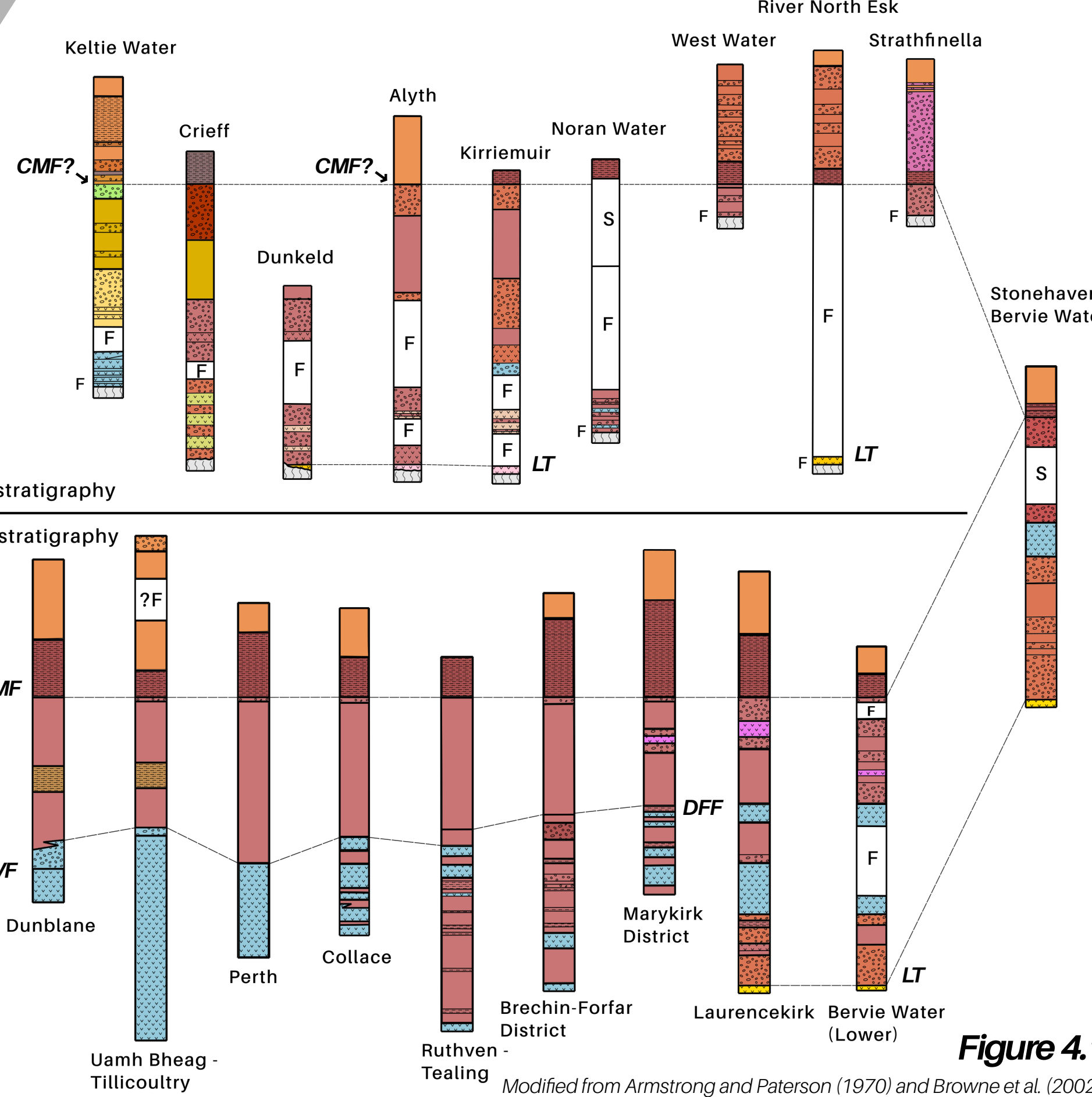


Figure 4.1

Devonian	Middle	Givetian	382.7 ± 1.6	To
		Eifelian	387.7 ± 0.8	A
			393.3 ± 1.2	F
	Lower	Emsian		A
			407.6 ± 2.6	Pr
		Pragian	410.8 ± 2.8	B
		Lochkovian		M
Silurian		419.2 ± 3.2		
	Pridoli	423.0 ± 2.3		
	Ludlow	427.4 ± 0.5		
	Wenlock	433.4 ± 0.8		

P Target horizons for new palynology sampling
R Target horizons for new radiometric sampling

Figure 4.2. Age control on the Lower Old Red Sandstone. Dates and sedimentological evidence suggest potential for a significant unconformity between the Cromlix and Scone formations.

Cromlix Mudstone Formation - an important, distinctive unit found along the length of the Strathmore Syncline's southern limb (Fig. 4.1)

- lithological description (and interpretation) vary between map areas
- No dating control available (Fig. 4.2), but potential for unconformity causes problems for interdigitating units on map

Lintrathen Tuff - provides one of two radiometric dates in entire basin! Key for stratigraphic framework

- Lithology and interpretation vary across the basin

Dundee Flagstone Formation - upper boundary marked by the locally highest fish-bearing beds - diachronous boundary, and interfingers with adjacent formations

Ochil Hills Volcanic Formation - porphyritic andesites correlated based on phenocryst assemblage

- lava flows are discontinuous

Effects and Outcomes:

- Updated geological maps, with a **coherent structural and stratigraphic interpretation**
 - Removal of map sheet boundary issues
 - Regional basis for map revisions - more robust interpretations
- Takes maximum **advantage of legacy data**, essential when restricted by time in the field
- Efficient, "rapid" method of map revision**, essential as traditional survey styles become less affordable, and effective for countries such as the UK with a long surveying history and high demand for accurate and consistent geological information across large areas
- Improved support for **groundwater management**, **geothermal prospectivity**, and **mineral resources** (building stones)
- Geological approach to **constraining the map boundary** - valuable alternative to boundaries of paper map sheets

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