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Glacial Striae Observations for Ireland Compiled from Historic Records

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INTRODUCTION

Landform mapping has been a primary method of data collection across the spectrum of earth sciences. These include geology (e.g. Gold et al., 1973), glaciology (e.g. Wright, 1912), hydrology (e.g. Hooke et al., 1994), hillslope geomorphology (e.g. Evans, 1977), planetary geology (e.g. Baker, 1981), volcanology (e.g. Thouret, 1999), and coastal geomorphology (e.g. Chandler and Brunsden, 1995) amongst others. Landforms were originally mapped by hand directly in the field; however the advent of remote sensing technologies has meant that larger areas can be mapped by fewer people and in less time (e.g. Clark, 1997). In short, the economical and often accuracy advantage of mapping remotely has meant that, in some environments and for some purposes, it is the preferred technique.

Research programs employing remotely sensed data have often mapped landforms ranging from several hundreds of metres to several kilometres in length, such as drumlins, end and ribbed moraines, and eskers. Dynamical assumptions based upon landform dimensions and properties (e.g. Kleman and Borgström, 1996) allow tentative reconstructions of the extent and dynamics of former ice sheets (e.g. Clark and Meehan, 2001). In particular, it is possible to reconstruct ice flow direction and changes in flow regime (including subglacial thermal and hydrological conditions). Striae observations have previously been incorporated into palaeo-ice sheet reconstructions (Kleman, 1990), however observations are often fragmented with small areal coverage. In short, they are rarely used for reconstructions over large areas.

Much of the early work of the Geological Survey of Ireland (GSI) involved the mapping of both hard rock and surficial geologies. In particular, extensive suites of both erosional and depositional glacial landforms inspired detailed and extensive field mapping and observation, although this was not a mandatory requirement and was often ignored in some areas, depending on the mapper's own interests. The results of this mapping were presented in the First Series ("1-inch" or 1:63,360) geological map sheets, published principally between 1860 and 1890. The geological memoirs accompanying the map sheets contained further detail and, in many instances, tabulated field observations such as striae.

This paper describes the compilation of over 4400 historic striae observations for the island of Ireland (covering ~84000 km^2), principally based upon the memoirs accompanying the First Series geological map sheets, but also including published (peer-reviewed journal articles and reports) and unpublished (field notes, theses) observations.

METHOD

The principal data source for this research was tabulated striae observations contained within memoirs accompanying the First Series GSI map sheets. Memoirs that contain striae observations are not equally distributed around the island, in part due to the diligence and experience of individual field geologists. However it should also be noted that striae are most clearly recorded on bedrock substrates, which are generally more exposed in the west, with central and eastern regions having a thicker till cover. Opportunities for striae observations were therefore more limited in these latter areas. As a final note, some observations also record overprinting (or cross-cutting) of different striae sets, often noting the relative ages of different sets.

The information recorded in tables contained within memoirs varies, depending upon the individual geologist with, at least, the broad location, orientation and a brief description of the specific location listed. By 1837 the Ordnance Survey had completed First Series topographic mapping of the country at the Six Inch scale (1:10560) and these maps were principally used by the field geologists to identify locations. Indeed many of the tables record the county, sheet number, quadrant, and townland that the observations fall within. However the map projections used were not consistent and varied between counties. The simplest and most effective method of transcribing the location of striae involved locating the observation on an original Six Inch map sheet and identifying the same point on a modern 1:50000 Ordnance Survey of Ireland map sheet, and recording a 12 figure grid reference in Irish National Grid coordinates.

In transcribing striae, it was also evident that descriptions of locations had different levels of locational accuracy. A subjective assessment of this accuracy was recorded on a scale from 1 to 5, ranging from the most accurate (where a full grid reference or precise identifiable location is given) to least accurate (where only a general area is known).

For the GSI memoirs, orientation was usually recorded with reference to cardinal points on a compass (rather than in degrees), generally to within 5º. Thus a value of 035º could be recorded as N35E in the memoirs, but the notation can be utilised with respect to each of the four cardinal points and so 035º could also be refer to E55N. This has added some complexity to the interpretation of these original observations.

In addition to the GSI memoirs, striae were transcribed directly from the First Series geological maps. There is undoubtedly duplication between these two data sets; however there are fewer observations recorded on the maps and these are often in different locations. Both sets have therefore been included for completeness. Our database distinguishes between these data sources.

Striae observations taken directly from the published literature vary in presentation of results. Some articles provide full grid references (e.g. Meehan, 1999), whilst others just contain outline maps showing striae locations.

All striae observation information was collated in a relational database comprising:

- 12-figure Irish National Grid reference,
- the source of the record,
- orientation of striae,
- presence and orientation of any cross-cutting striae, and
- locational accuracy of the record.

RESULTS

Individual records were collated from (number in brackets):

- GSI memoirs (2300),
- Geological survey maps (1400), and
- Published and unpublished literature (700).

The database therefore totals over 4400 individual striae measurements, although there is some duplication of individual records between sources. Smith et al (2007) presented the complete data set for Ireland showing the positions and orientations of striae that most likely date from the last (late Devensian) glaciation (c. 25000-13000 BP). The records were imported into ESRI ArcGIS for production of the final map. The base map was constructed from a relief-shaded digital elevation model (Shuttle Radar Topography Mission; http://www2.jpl.nasa.gov/srtm/), hydrographic data comprising lakes and rivers (Digital Chart of the World; http://www.maproom.psu.edu/dcw/), and a coastal outline (University of Ulster, Coleraine, UK).

DISCUSSION

Striae observation coverage of Ireland is extensive, however it is far from uniform. Areas of dense observations are to be found in the west (Connemara), north-west (Donegal), and north-east (Down) regions of the island. Additional clusters can also be noted on mountain blocks in the east (Wicklow) and south-west (Kerry). All these regions are either bedrock scoured (Connemara) or mountainous and therefore have little surficial cover. Other areas with observations are predominantly coastal (e.g. River Shannon mouth). There is an almost complete lack of observations in the central and southern areas of the island. These data are currently being used to reconstruct ice flow patterns during the late Devensian, and will be reported upon separately.

It is important to note that there are limitations to the data:

- there are potential duplications of observations between different sources,
- the accuracy of striae location varies and is qualitatively assessed,
- some observations appear just offshore and likely fall within the inter-tidal zone,
- some observations fall on islands that are not recorded on the basemap, and
- base map data are of different provenance and, whilst fit for display purposes, are not representative of “best available” data.

CONCLUSIONS

- Research presented here represents one of the largest compilations of striae observations, comprising over 4400 individual observations.
- Striae observations have been collated using historic records dating from the 1850s onwards, and published (peer-reviewed) and unpublished literature.

- Striae observations are not uniformly distributed, being strongly clustered around mountainous (e.g. Mourne Mountains, Wicklow, Macgillicuddy's Reeks) and coastal zones.
- These observations will form the basis of a reconstruction of former ice sheet flow.

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