

A Practical Guide To Fluid Inclusion Studies

Downloaded from <http://jgs.lyellcollection.org/> by guest on August 21, 2015

JGS

Research article
Published Online First

Journal of the Geological Society
doi:10.1144/jgs2015-058

Silurian–Devonian magmatism, mineralization, regional exhumation and brittle strike-slip deformation along the Loch Shin Line, NW Scotland

R. E. Holdsworth¹, E. Dempsey¹, D. Selby¹, J. R. Darling², M. Feely³, A. Costanzo⁴, R. A. Strachan⁵, P. Waters⁶, A. J. Finlay⁷ & S. J. Porter⁸

¹ Department of Earth Sciences, Durham University, Durham DH1 3LE, UK
² School of Earth and Environmental Sciences, University of Portsmouth, Portsmouth PO1 3QL, UK
³ Earth and Ocean Sciences, School of Natural Sciences, Quadrangle Building, National University of Ireland, Galway, Ireland
⁴ Eurasian Consolidated Minerals Pty Ltd, Level 1, 415 Riverside Road, Hawthorn East, VIC 3123, Australia
⁵ Origin Analytical, 1 Ravenscroft Court, Buttington Enterprise Park, Welshpool SY21 8SL, UK
⁶ Chemostrat, 1 Ravenscroft Court, Buttington Enterprise Park, Welshpool SY21 8SL, UK
⁷ Correspondence: r.e.holdsworth@durham.ac.uk

Abstract: The Loch Shin Line is a geological–geophysical lineament associated with a zone of mantle-derived apinites, granites and strike-slip faulting that runs NW–SE across the Moine Nappe, northern Scotland. U–Pb zircon and Re–Os molybdenite dating of the Loch Shin and Groutie plutons, which lie immediately SW of the NW–SE Loch Shin–Strath Fleet fault system, yield c. 427–430 Ma ages that overlap within error. They also coincide with previously obtained U–Pb zircon ages for the Rogart pluton, which lies along-strike to the SE. Field and microstructural observations confirm the similarity and contemporaneous nature of the plutons and associated sulphide mineralization. Fluid inclusion analyses place further constraints on the *P*–*T*–*X* conditions during regional late Caledonian exhumation of the Moine Nappe. Synchronous to slightly younger brittle dextral strike-slip faulting along the WNW–ESE Loch Shin–Strath Fleet Fault System was probably antithetic to sinistral movements along the nearby Great Glen Fault Zone. Our findings support the hypothesis that the Loch Shin Line acted as a deep crustal channelway controlling the ascent and emplacement of Silurian magmas into the overlying Moine Nappe. We propose that this deep structure corresponds to the southeastern continuation of the Precambrian-age Laxford Firth shear zone in the buried Lewisian autochthon.

Supplementary Material: Field photographs, photomicrographs and fluid inclusion information are available at <http://www.geolsoc.org.uk/SUP18859>.

Received 15 May 2015; revised 26 June 2015; accepted 29 June 2015

Orogenic belts worldwide are characterized by interlinked systems of thrust, strike-slip and extensional faults and, at deeper crustal levels, by shear zones that collectively accommodate crustal deformation in broad continental deformation zones during plate collision (i.e. ‘block and flake tectonics’; Dewey *et al.* 1986). The location, geometry and persistence of faults and shear zones in such regions are known to be influenced by the reactivation of crustal-scale pre-existing structures (Sutton & Watson 1986; Holdsworth *et al.* 1997, 2001). These same structures are also known to act as channelways that control the upward migration and emplacement of hydrous mineralizing fluids and magmas (e.g. O’Driscoll 1986; Hutton 1986; Jacques & Reavy 1994; Richards 2013). This coincidence of geological processes has greatly assisted in the analysis of orogenic deformation histories worldwide, as dating of igneous intrusions and/or mineralization events using geochronology can also be used to constrain the absolute ages of associated deformation events in the adjacent wall rocks (e.g. Paterson & Tobisch 1988; Schofield & D’Lemos 1998; Rosenberg 2004).

Integrated structural and geochronological studies of deformed igneous intrusions have played a key role in constraining the timing of events within the Early Palaeozoic Caledonian orogeny in Scotland (Fig. 1a). Following Ordovician arc–continent collision (the Grampian event), the final closure of Iapetus involved the oblique collisions of three palaeo-continents, Laurentia, Baltica and Avalonia, during the mid- to late Silurian (e.g. Soper *et al.*

1992; Torsvik *et al.* 1996). In NW Scotland, regional deformation occurred as a result of the sinistral oblique Scandian collision of Baltica with Laurentia. Crustal thickening here was overlapped and followed by major sinistral displacements along orogen-parallel strike-slip faults such as the Great Glen Fault Zone (Fig. 1a), heralding a transition from a regime of sinistral transpression to transtension (Dewey & Strachan 2003, and references therein). Igneous activity and associated mineralization related to slab breakoff was associated with this transition so that earlier granites were syntectonically emplaced along Scandian thrusts (e.g. Naver Thrust; see Holdsworth & Strachan 1988; Kinny *et al.* 2003; Goodenough *et al.* 2011; Kocks *et al.* 2013), and later, volumetrically larger volumes of melt were emplaced along steeply dipping strike-slip or normal faults (e.g. Great Glen Fault Zone; Hutton 1986; Hutton & McErlain 1991; Jacques & Reavy 1994; Stewart *et al.* 2001). In many cases the controlling faults or shear zones are exposed at the present-day surface, but others are more enigmatic features. As illustrated by Jacques & Reavy (1994) they are commonly inferred ‘buried’ structures based on geological, geophysical or geochemical alignments that define regional-scale transverse lineaments that run generally at high angles to the orogenic strike. One of these NW–SE features, the Loch Shin Line, first defined by Watson (1984), is associated with an anomalous zone of mantle-derived apinites, granites and brittle faulting in the Moine Nappe SE of the Moine Thrust on the north side of the Assynt Culmination

© 2015 The Author(s). Published by The Geological Society of London. All rights reserved. For permissions: <http://www.geolsoc.org.uk/permissions>. Publishing disclaimer: www.geolsoc.org.uk/pub_disclaimer

Request PDF on ResearchGate A Practical Guide to Fluid Inclusion Studies This essentially practical manual is designed to fill the gap. Buy A Practical Guide to Fluid Inclusion Studies on bodybuildinghumangrowthhormone.com ? FREE SHIPPING on qualified orders. A Practical Guide to Fluid Inclusion Studies [T.J. Shepherd, A.H. Rankin, D. H. M. Alderton] on bodybuildinghumangrowthhormone.com *FREE* shipping on qualifying offers. A Practical Guide to Fluid Inclusion Studies. Front Cover. T. J. Shepherd, A. H. Rankin, D. H. M. Alderton. Blackie, - Fluid inclusions - pages. A practical guide to fluid inclusion studies. Front Cover. T. J. Shepherd, A. H. Rankin, D. H. M. Alderton. Blackie, - Science - pages. A practical guide to fluid inclusion studies / T.J. Shepherd, A.H. Rankin, D.H.M. Alderton. Author. Shepherd, T. J.. Other Authors. Rankin, A. H.; Alderton. A Practical Guide to Fluid Inclusion Studies. R. A. D. Patrick. Mineralogical Magazine; June v. 50; no. ; p. ; DOI: /minmag . A Practical Guide to Fluid Inclusion Studies by T.J. Shepherd, , available at Book Depository with free delivery worldwide. T. J. Shepherd, A. H. Rankin and D. H. M. Alderton A Practical Guide to Fluid Inclusion Studies. Glasgow and London (Blackie), xi + Get this from a library! A practical guide to fluid inclusion studies. [T J Shepherd; A H Rankin; D H M Alderton]. A practical guide to fluid inclusion studies. by T J Shepherd; A H Rankin; D H M Alderton. Print book. English. Glasgow: Blackie ; New York: Distributed. bodybuildinghumangrowthhormone.com: A Practical Guide to Fluid Inclusion Studies () by T.J. Shepherd; A.H. Rankin; D. H. M. Alderton and a great selection of similar. A practical guide to fluid inclusion studies / T.J. Shepherd, A.H. Rankin, D.H.M. Alderton Subjects: Fluid inclusions. Physical Description: xi, p.: ill. ; 24 cm. T.J. Shepherd is the author of A Practical Guide to Fluid Inclusion Studies (avg rating, 0 ratings, 0 reviews, published). Shop our inventory for A Practical Guide to Fluid Inclusion Studies by T.J., Rankin, A.H., Alderton, D. H. M. Shepherd with fast free shipping on every used book. A practical guide to fluid inclusion studies UTS Library. Find great deals for A Practical Guide to Fluid Inclusion Studies by A. H. Rankin, T. J. Shepherd and D. H. Alderton (, Hardcover). Shop with confidence on inclusion data and for modelling bulk fluid properties. Chemical Geology, , 3 A practical guide to fluid inclusion studies. Blackie and Son Ltd, Glasgow. A Practical Guide to Fluid Inclusion Studies by T. J. Shepherd, A. H. Rankin, D. M. H. Alderton. (Hardcover). Buy A Practical Guide to Fluid Inclusion Studies by T.J. Shepherd, etc., A.H. Rankin, D. H. M. Alderton (ISBN:) from Amazon's Book Store. Buy A Practical Guide to Fluid Inclusion Studies by T. J. Shepherd, A. H. Rankin, D. M. H. Alderton (ISBN:) from Amazon's Book Store. Everyday.

[\[PDF\] The Neurologic Examination Of Beagle Dogs In Toxicity Tests](#)

[\[PDF\] Radical Spaces Of Poetry](#)

[\[PDF\] Primate Behaviour And Social Ecology](#)

[\[PDF\] Perspectives In Psychology](#)

[\[PDF\] Implementation Of The Private Securities Litigation Reform Act Of 1995: Hearing Before The Subcommit](#)

[\[PDF\] Understanding Alzheimers Disease](#)

[\[PDF\] Studying Shakespeare In Performance](#)