

Craig Magee, James D Muirhead, Alex Karvelas, Simon P Holford, Christopher A-L Jackson, Ian D. Bastow, Nick Schofield, Carl TE Stevenson, Charlotte McLean, William McCarthy and Olga Shtukert, 2016. Lateral Magma Flow in Mafic Sill-complexes. *Acta Geologica Sinica* (English Edition), 90(supp. 1): 4-5.

## Lateral Magma Flow in Mafic Sill-complexes

Craig Magee<sup>1,\*</sup>, James D Muirhead<sup>2</sup>, Alex Karvelas<sup>3</sup>, Simon P Holford<sup>4</sup>, Christopher A-L Jackson<sup>1</sup>, Ian D. Bastow<sup>1</sup>, Nick Schofield<sup>5</sup>, Carl TE Stevenson<sup>6</sup>, Charlotte McLean<sup>7</sup>, William McCarthy<sup>8</sup> and Olga Shtukert<sup>3</sup>

1 *Basins Research Group, Department of Earth Science and Engineering, Imperial College, London, SW7 2BP, UK*

2 *Department of Geological Sciences, University of Idaho, Moscow, Idaho 83844, USA*

3 *Schlumberger Multiclient, Schlumberger House, Buckingham Gate, West Sussex, RH6 0NZ, UK*

4 *Australian School of Petroleum, University of Adelaide, Adelaide, SA 5005, Australia*

5 *Geology & Petroleum Geology, School of Geosciences, University of Aberdeen, Aberdeen, AB24 3UE, UK*

6 *School of Geography, Earth & Environmental Sciences, University of Birmingham, Birmingham, B15 2TT, UK*

7 *School of Geographical and Earth Sciences, University of Glasgow, Glasgow, G12 8QQ, UK*

8 *Department of Earth Sciences, University of St Andrews, St Andrews, KY16 9AL, UK*

The structure of upper crustal magma plumbing systems controls the distribution of volcanism and influences tectonic processes. Delineating the structure and volume of plumbing systems is, however, difficult because: (1) active intrusion networks cannot be directly accessed; (2) field outcrops are commonly limited; and (3) geophysical data imaging the sub-surface is restricted in its areal extent and resolution. This has led to models involving the vertical transfer of magma via dykes, extending from a melt source to overlying reservoirs and eruption sites, being favoured in the volcanic literature. Whilst numerous studies document vertical magma transport in dyke-dominated volcanic plumbing systems, it is widely accepted that giant radiating dyke swarms can facilitate lateral magma flow over hundreds to thousands of kilometres. Dykes and dyke swarms have therefore been extensively studied and it is clear that they can significantly influence tectonic (e.g., rifting) and volcanic processes. In contrast, sills and sill-complexes have received relatively little attention in the literature. This is despite recent field-, seismic reflection- and modelling-based research showing that extensive sill-complexes can facilitate magma transport over distances of up to 12 km vertically and 4100 km laterally. The aim of this contribution is to synthesize field- and seismic

reflection-based observations of mafic sill-complexes (e.g., Fig. 1), investigating their emplacement mechanics and how they may impact tectonic processes. Seismic reflection data has particularly revolutionised our understanding of sill-complexes because they allow 3D images of the intrusions and surrounding host rock to be scrutinised (e.g., Fig. 1). Overall, most of mafic sill-complexes occur in sedimentary basins (e.g., the Karoo Basin, South Africa), although some intrude crystalline continental crust (e.g., the Yilgarn Craton, Australia), and consist of interconnected sills and inclined sheets (e.g., Fig. 1). We show that sill-complex emplacement is largely controlled by host rock lithology and structure and the state of stress. We argue that plumbing systems need not be dominated by dykes and that magma can be transported within widespread sill-complexes, promoting the development of volcanoes that do not overlie the melt source. The extent to which active volcanic systems and rifted margins are underlain by sill-complexes remains poorly constrained. We conclude that it is crucial to consider that plumbing systems may be characterised by sill-complexes when constraining magmatic and tectonic processes, melt volumes and melt sources.

\* Corresponding author. E-mail: [c.magee@imperial.ac.uk](mailto:c.magee@imperial.ac.uk)

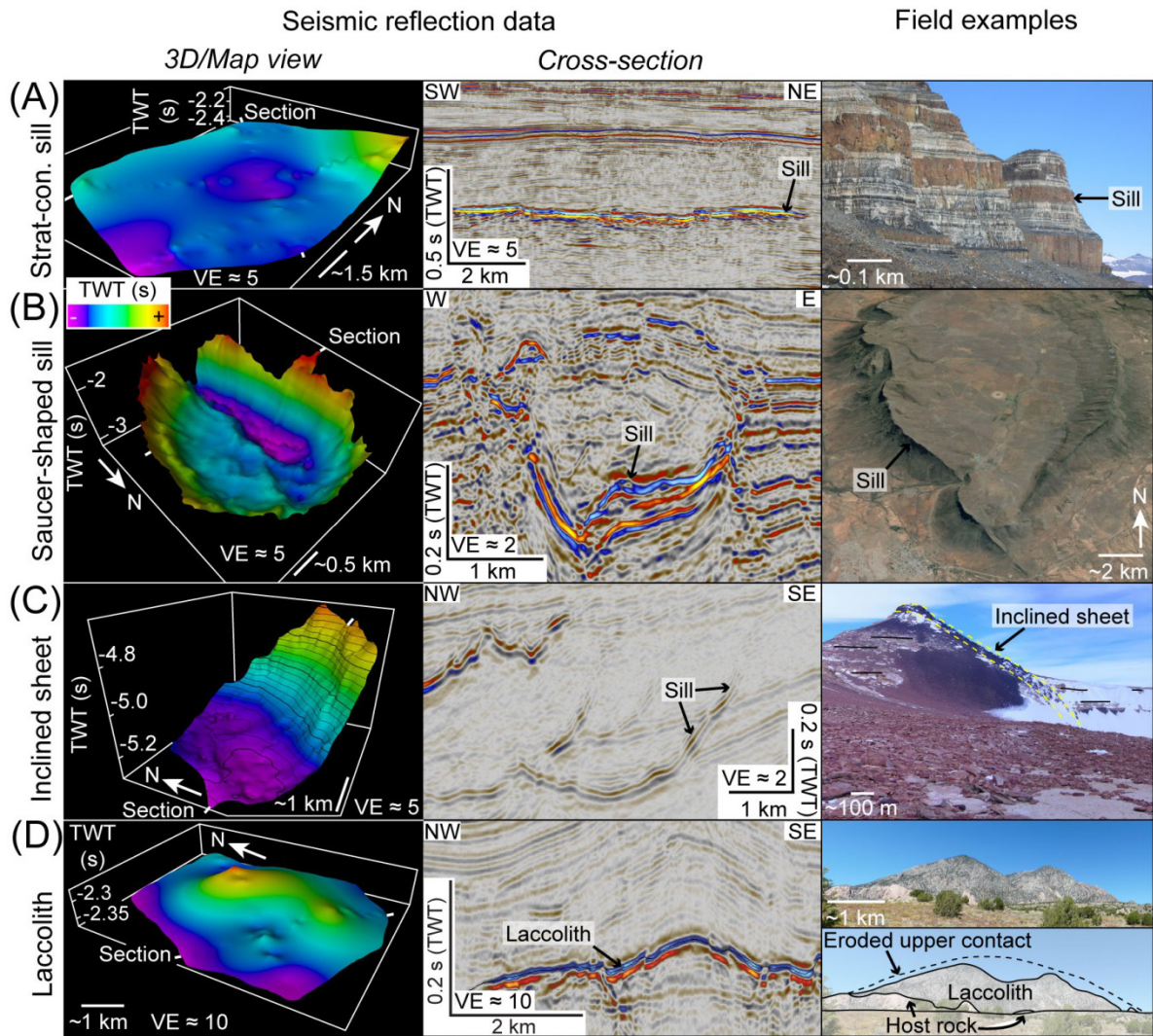


Fig. 1. Seismic and field examples of: (A) strata-concordant (strat-con.) sills observed offshore southern Australia and in the Theron Mountains, Antarctica (field photo courtesy of Donny Hutton); (B) saucer-shaped sills observed in seismic data from the Exmouth Sub-basin, NW Australia and the Golden Valley Sill in South Africa (Google Earth image); (C) inclined sheets in the Rockall Basin and Antarctica; and (D) laccoliths observed offshore southern Australia and in the Henry Mountains, Utah, USA. Vertical axes in seismic images are in two-way travel time (TWT) and are vertically exaggerated (VE).