The Northern Margin of the Ferrar Large Igneous Province: Petrogenesis and Differentiation of the Tasmanian Dolerites and Kangaroo Island basalts

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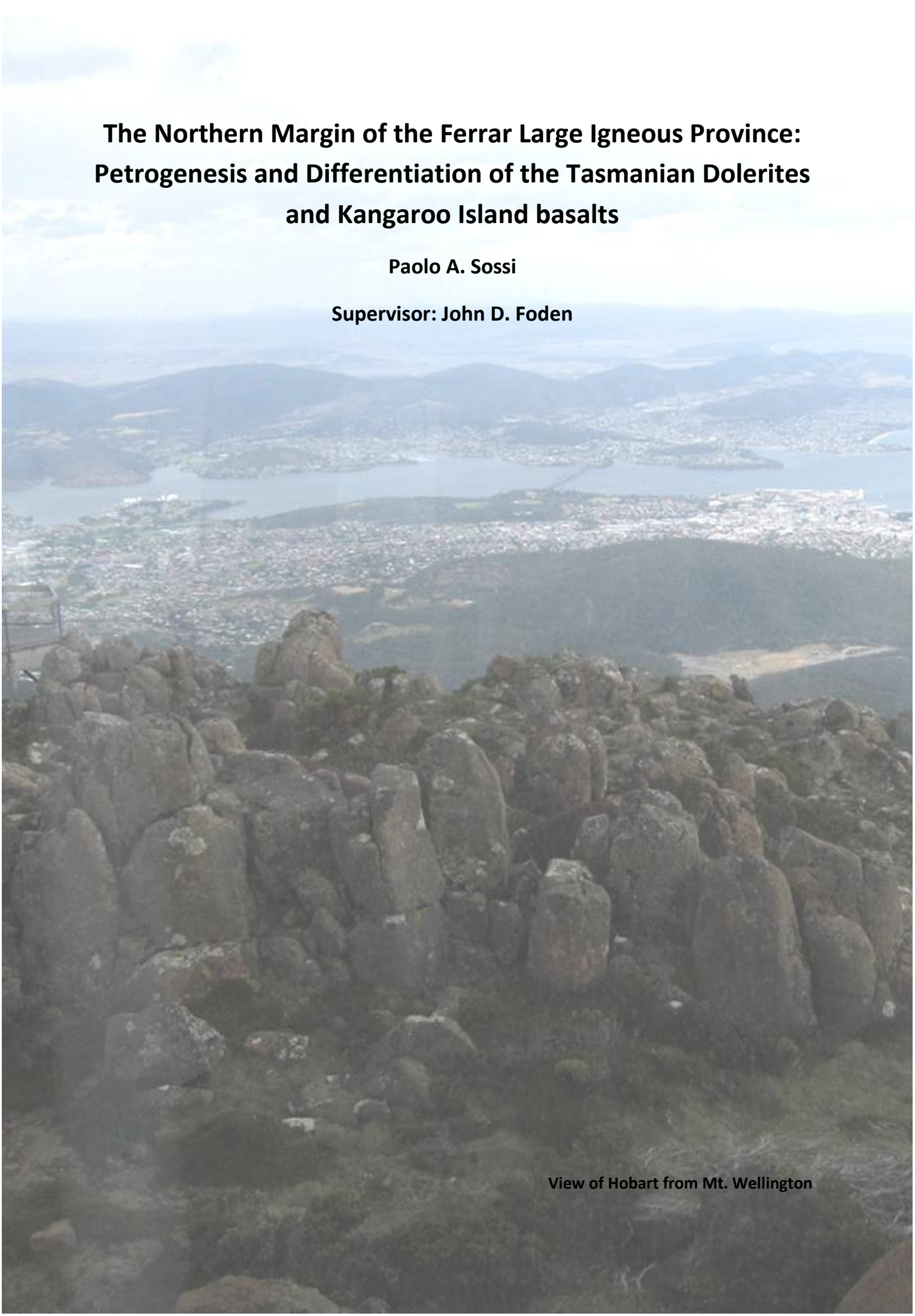

View of Hobart from Mt. Wellington

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Guide to the Thesis

This thesis, entitled *"The Northern Margin of the Ferrar Large Igneous Province: Petrogenesis of the Tasmanian Dolerites and Kangaroo Island Basalts"*, investigates magmatism associated with this large igneous province on a range of scales by employing varied chemical and isotopic techniques. Owing to the length of this thesis, it has been subdivided into 5 separate sections that can be read independently, though they are best treated as composite chapters of the same story.

Section 1.0., *Analytical Methods,* is presented at the beginning of the thesis, as it details the procedures by which the data was obtained, and thus the readers may assess the uncertainties and accuracies of each of the methods employed before the data is subjected to an interpretative analysis in the later sections. Additionally, because the project has a strong emphasis on quantitative chemistry, the analytical techniques are necessarily well-refined. The methods employed here cover not only the more traditional aspects of geochemistry (such as X-Ray Fluorescence and Electron Probe Micro-Analysis) but also certain hitherto esoteric fields (particularly Iron Isotope Geochemistry). Since these more specialised techniques are not widespread in literature, it is considered beneficial to present them here.

A general overview of the field locations, and the physical and petrographic characteristics which constitute a classification scheme for the rocks, is detailed in Section 2.0. (*General*). This chapter provides a summary of the geological history of the Tasmanian Dolerites and Kangaroo Island basalts, and then proceeds to define a petrologically-based classification for the samples used in the later sections of the study. Interpretation and chemical analyses are kept to a minimum, rendering an objective view of the samples and their setting.

The discussion-based sections of the thesis are then presented as 3 discrete manuscripts, each with an abstract, introduction and conclusion. Occasionally, references will refer the readers to figures or equations from an accompanying section.

A treatment of the origin and petrogenesis of the basaltic magmas of the Tasmanian Dolerites and Kangaroo Island is eludicated upon in Section 3.0., *The Mantle Source*. This study focuses on the chemical characteristics of the least-fractionated mafic magmas of the province, using their distinctive properties to infer the timing and conditions of mantle melting. An interpretation of their petrogenesis is made in keeping with broader-scale tectonic considerations, in order to create a consistent picture for the generation of the Ferrar Large Igneous province, of which they are a part.

In edifying the chemistry of the source and its derivative magmas, the differentiation history of the magmas following their emplacement in the crust is analysed in Section 4.0., *Differentiation*. An extensive array of samples from the Red Hill intrusion, southern Tasmania are utilised for this chapter, as they record the variability shown by the differentiating magma. The large suite of rocks permits a detailed study of mineral-liquid relationships, whose systematics are interpreted in light of thermodynamic and experimental studies. The effects of various chemical parameters on the evolution of the tholeiitic trend are assessed, with a view to characterising its end-member products, and developing a model for the formation of A-Type granitoids.

Section 5.0. *Iron Isotope Variations*, represents a Nature manuscript that was submitted prior to the consignment of this work ((*In Submission)* Sossi, P.A., Foden, J.D., Halverson, G.P., 2010. Redox-controlled iron isotope fractionation during magmatic differentiation. *(Nature Geoscience)*.) For the first time this provides a quantitative determination of the fractionation factors that govern Fe isotopic fractionation in magma systems with changing saturation of ferrous and ferric iron–bearing minerals