Pressure-temperature-deformation paths from P-T pseudosections and zoned garnets: implications for metamrophic evolution of the Eastern Fold Belt of the Mt Isa Inlier

Mohammad Sayab and Mike Rubenach
James Cook University, QLD

Introduction

The Eastern Fold Belt of the Mt Isa Inlier hosts polymetamorphic signatures of pro- and retrograde mineral assemblages. Examples include And-Crd-St-Bt-Ms in the Snake Creek Anticline (Rubenach and Lewthwaite, 2002) and Rosebud Syncline (Reinhardt, 1992). The occurrence of such polymetamorphic mineral assemblage implies that the Eastern Succession of the Mt Isa inlier has undergone discrete phases of metamorphism and associated deformation. This study seeks to understand the tectono-thermal evolution of the Eastern Fold Belt. Detailed structural mapping and systematic sampling has been carried out in the key areas of the Eastern Fold Belt to answer some of the fundamental and most critical questions, e.g., What is the link between the polymetamorphic nature of the Eastern Fold Belt with crustal-scale deformation episodes? We present our preliminary P-T results based on microstructural relationships and thermodynamic modeling from the Snake Creek Anticline (samples Sc192, Sc189, Sc112), Tommy Creek Block (Tc186) and White Blow Formation (Wb45) of the Mary Kathleen Fold Belt.

P-T pseudosections and geothermobarometric constraints

P-T pseudosections, that is, maps of stable mineral assemblages in P-T-X space were constructed using bulk XRF analysis (mol%) of each sample using Thermocalc-3.2 using the most recent upgrades in the chemical system (MnO-Na_2O-CaO-K_2O-FeO-MgO-Al_2O_3-SiO_2-H_2O). The pseudosections were contoured for the X_{Fe}, X_{Mn} and X_{Ca} in garnet with respect to increasing pressure and temperature to provide as means for determining P-T points for the start of the garnet growth that can be tested by microprobe analyses. These compositional isopleths should intersect at a single pressure and temperature for the onset of garnet growth and diverge as growth continues due to the fractionation (e.g., Vance and Mahar, 1998). P-T estimates were also carried out using the average P-T mode of the Thermocalc-3.21 via microprobe analysis of garnet rim along with matrix mineral phases (e.g., plagioclase rim, biotite, muscovite) and the mineral end-member activities were initially calculated with program-AX (http://www.esc.cam.ac.uk/astaff/holland/index.html).

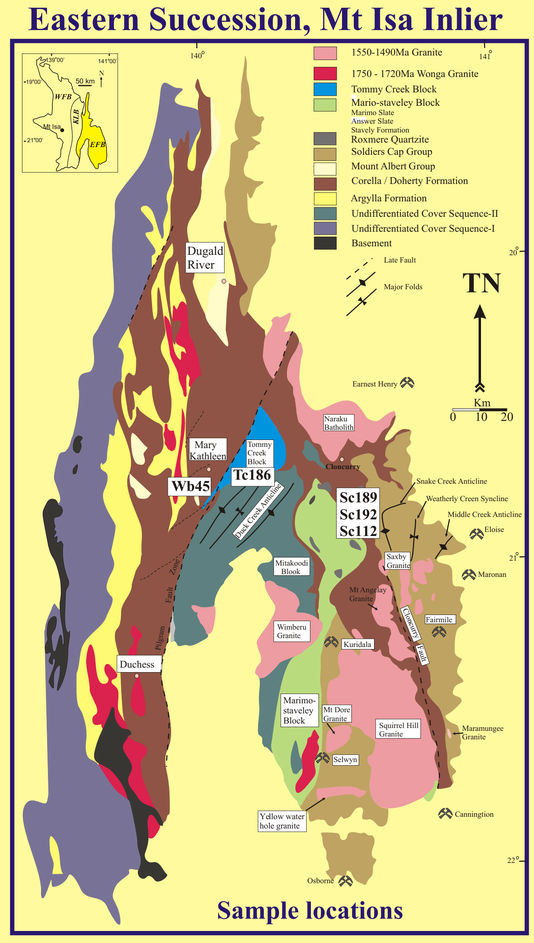
The chlorite and plagioclase inclusions in the core and median region of the garnet porphyroblasts in samples Sc192 and Sc189 and lack of chlorite in the matrix is predicted by the pseudosections by X_{Mn}, , X_{Fe} and X_{Ca} compositional isopleths for the garnet core intersection in Chl-Bt-Pl-Grt stability field. Garnet rim, matrix plagioclase, biotite and muscovite geothermobarometric estimates using the average P-T feature of Thermocalc-3.21 lie within Grt-Pl-Bt field. In Sc192, the garnet core grew at 5.6-6.1kb/526°C, whereas the rim with matrix phases grew at 6.5 1.1kb/602 27°C. For sample Sc189, the garnet-core grew at 4.4-4.7kb/526-530°C, whereas the rim grew at 5.5 1.2kb/581 26°C. These are the highest pressure estimates so far reported from any part of the Eastern Fold Belt of the Mt Isa Inlier. Texturally, the inclusion trails within the garnets are fine- to median-grained as compared to the matrix minerals and are not continuous, i.e., the matrix foliation is strongly deflected around the garnets, suggests that-the garnet growth occurred early in the deformation history (e.g., Passchier and Trouw, 1998).

The garnet core compositional isopleths in sample Sc112 and Wb45 intersect at 3.7-3.9kb/548-550°C and 3.7-4.5kb/544-547°C, respectively. For sample Sc122, garnet rim plus matrix mineral phases indicate 4.8 1.3kb/592 32°C. No average P-T calculations were been made for sample Wb45 as no plagioclase was found in the matrix. However, the pseudosection geometry and textures of Wb45 are very similar to that of Sc112, it is assumed that Wb45 had a similar path to Sc112. For sample Tc189, the garnet core grew at 2.1-2.2kb/510-515°C, whereas the rim plus matrix phases have formed at 4.8 1.1kb/600 29°C. All three of these samples (Sc112, Wb45 and Tc189) contain inclusions that are continuous with the matrix foliation.

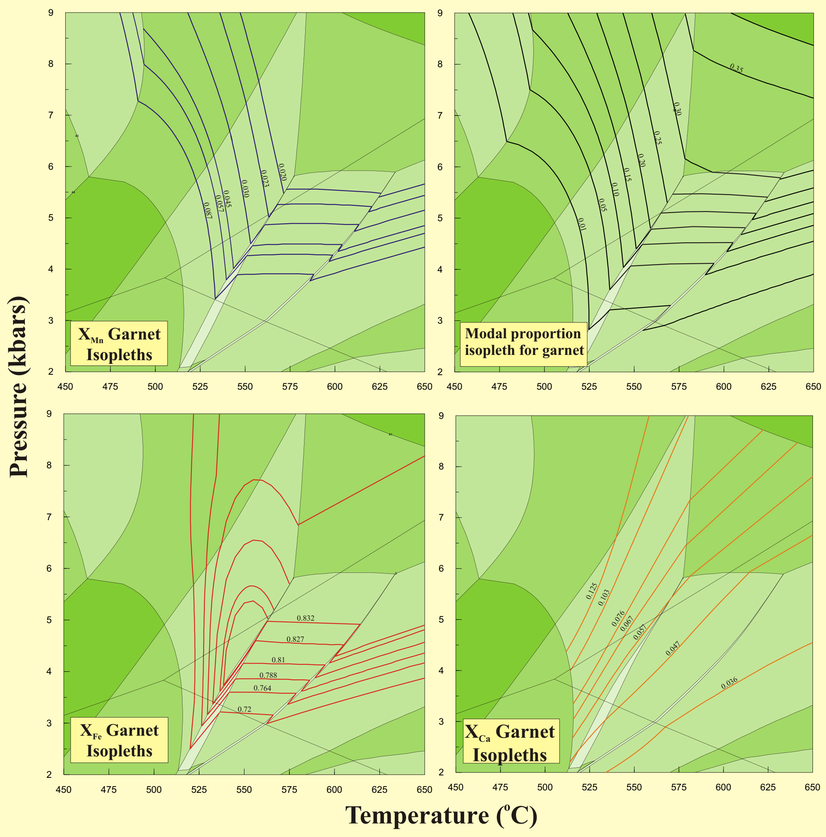
Tectonic implications

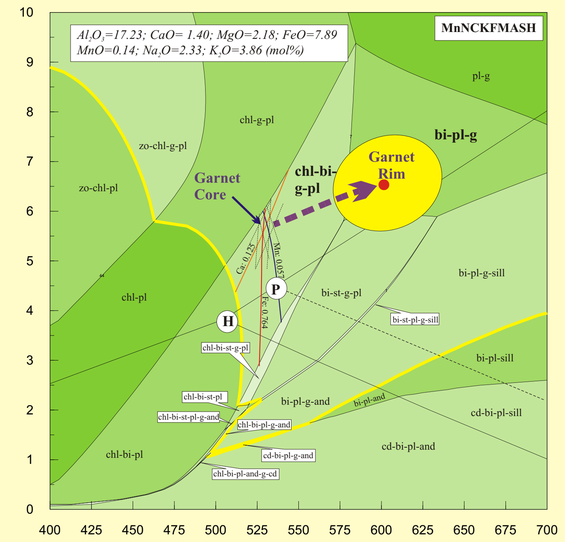
P-T paths from sample Sc112, Wb45 and Tc186 appear to be the part of the classic P-T path proposed by Rubenach and Lewthwaite (2002). However, the P-T paths from sample Sc192 and Sc189 show near-isobaric heating at elevated pressure. Significantly, the garnets displaying elevated P-T growth conditions appear to be older based on textural evidence (i.e., truncated inclusion trails) than the relatively low-pressure samples (i.e., continuous inclusion trails). As these two rocks were collected near the vicinity of Camel Hill and Cloncurry faults, which are interpreted as thrust/reverse faults, it is suggested that the garnets from sample Sc189 and Sc192 began to grow at elevated P-T conditions at middle crustal levels followed by rapid exhumation and cooling along the faults, or these garnets formed at early high pressure phase followed by near-isothermal decompression.

Eastern Succession, Mt Isa Inlier

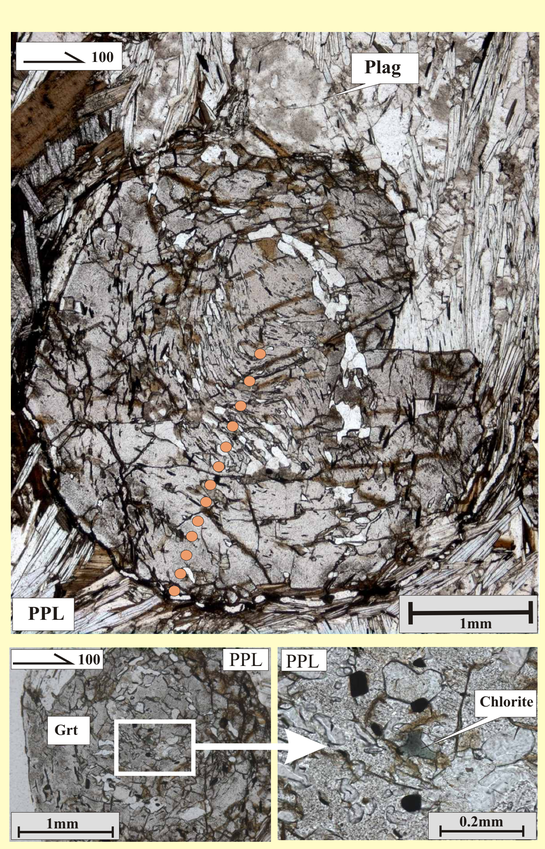


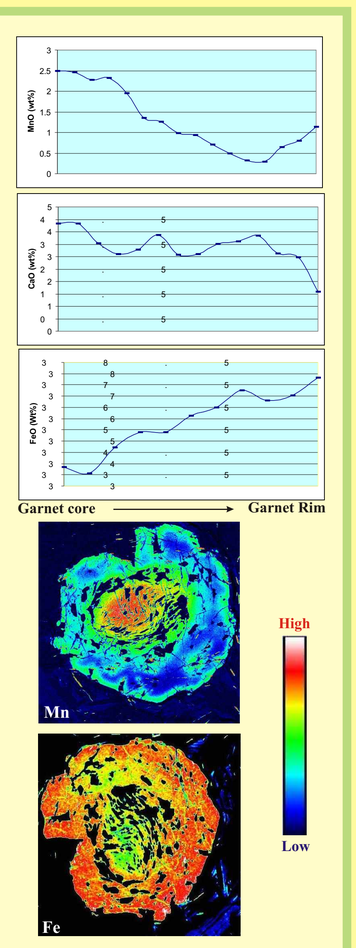
Sample No. SC-192
Snake Creek Anticline



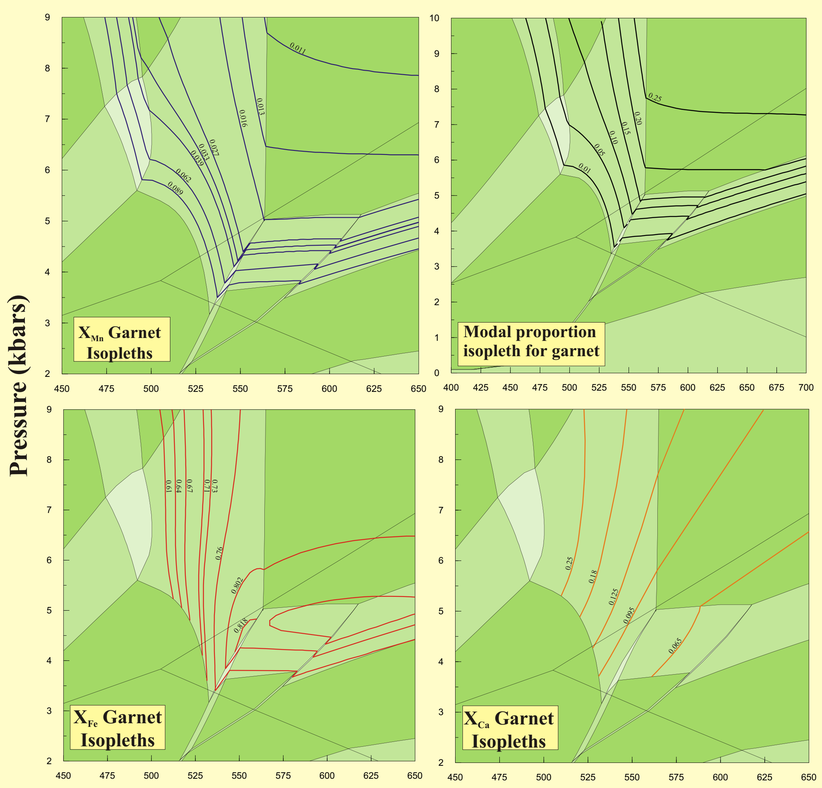


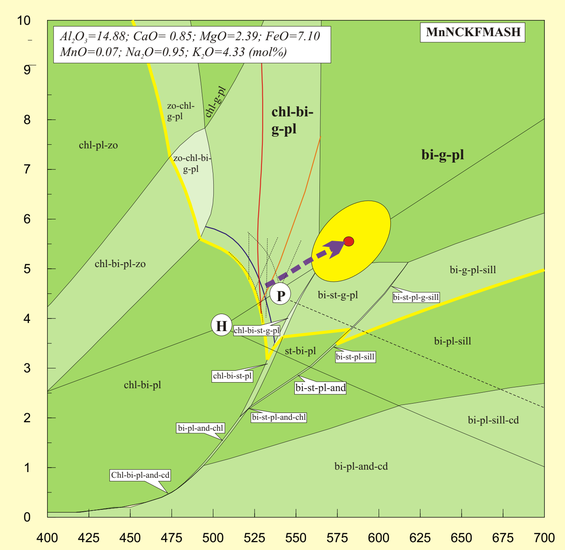
Garnet rim (Average P-T mode; Thermocalc-3.2)
T: 602 27°C
P: 6.5 1.1kbars
sigfit: 0.9
Garnet core (intersection isopleths)
T: 526-532°C
P: 5.6-6.1kbars



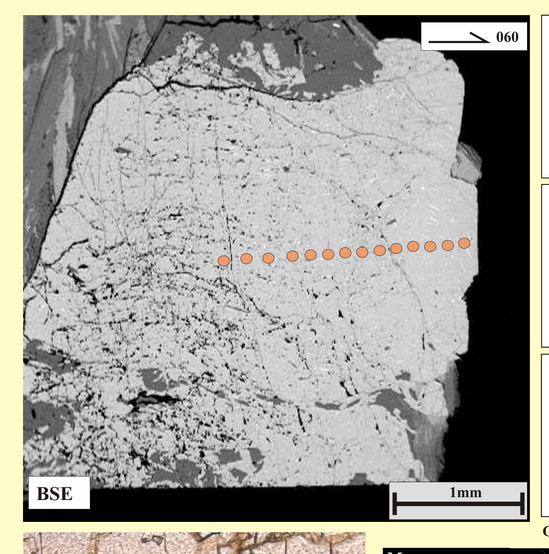


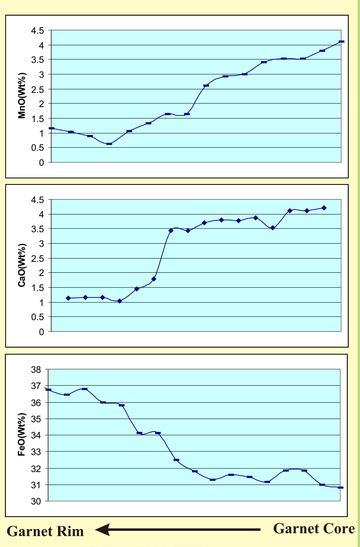
Sample No. SC-189
Snake Creek Anticline





Garnet rim (Average P-T mode; Thermocalc-3.2)
T: 581 26°C
P: 5.5 1.2kbars
sigfit: 0.6
Garnet core (intersection isopleths)
T: 526-530°C
P: 4.4-4.7kbars



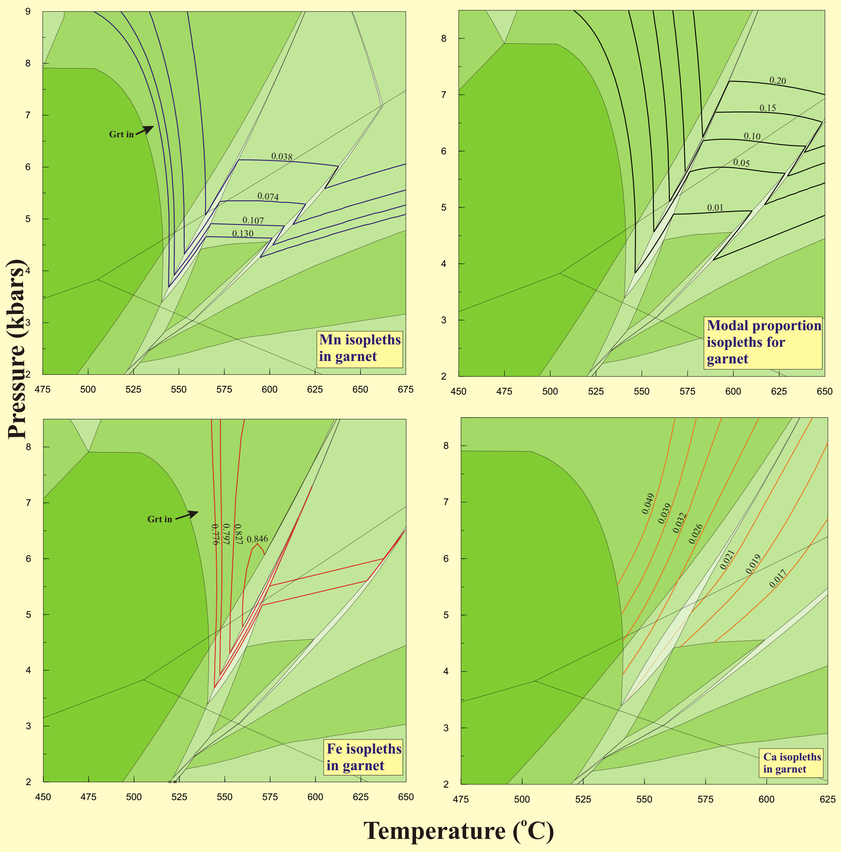


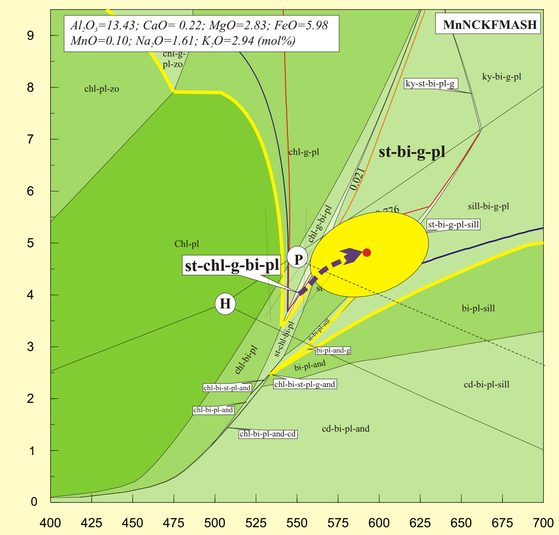
AMIRA INTERNATIONAL
Australian Government Geoscience Australia
JCU James Cook University
CSIRO
The University of Western Australia
MONASH UNIVERSITY
The University of Melbourne

Pressure-temperature-deformation paths from P-T pseudosections and zoned garnets: implications for metamrophic evolution of the Eastern Fold Belt of the Mt Isa Inlier

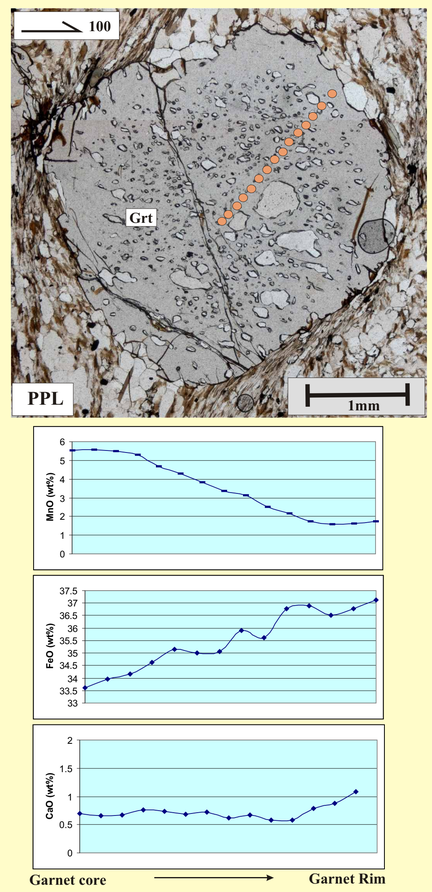
Mohammad Sayab and Mike Rubenach
James Cook University, QLD

Sample No. SC-112
Snake Creek Anticline

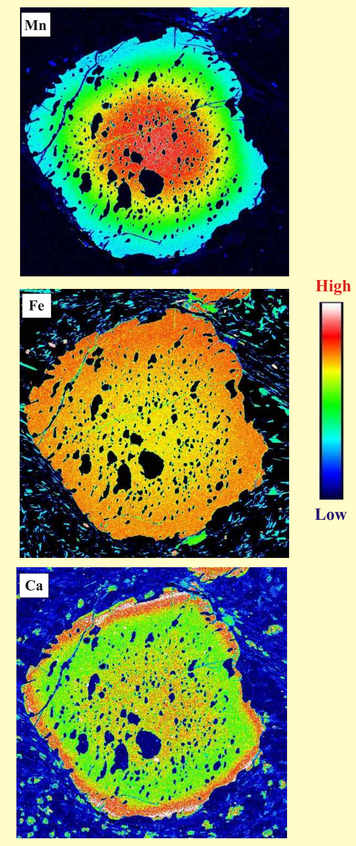




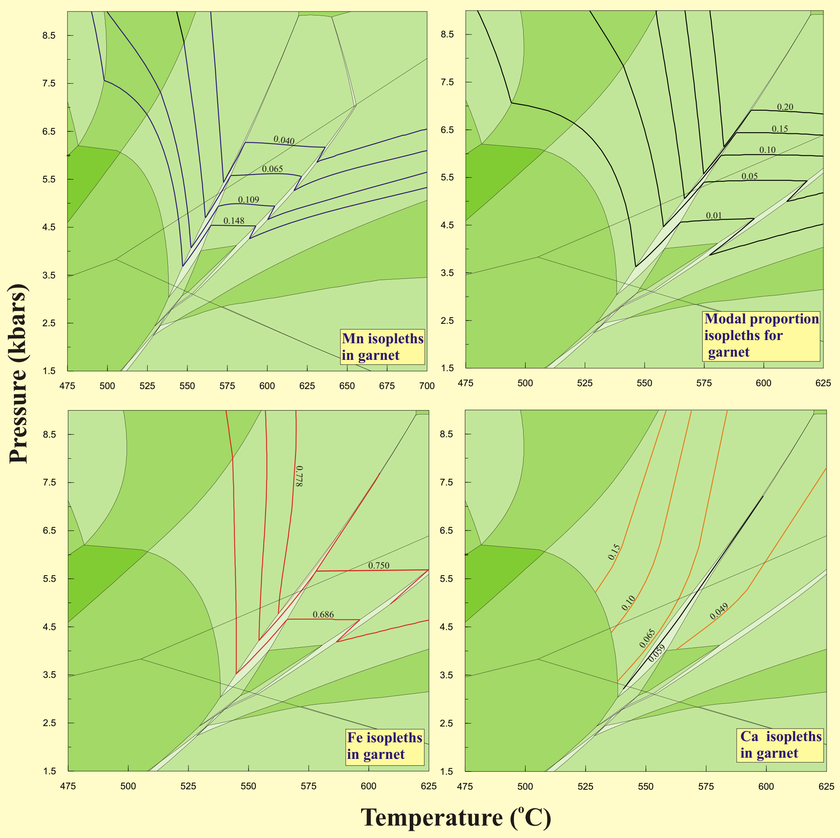
Garnet rim (Average P-T mode; Thermocalc-3.2)
T: 592 32°C
P: 4.8 1.3kbars
sigfit: 1.0
Garnet core (intersection isopleths)
T: 548-550°C
P: 3.7-3.9kbars

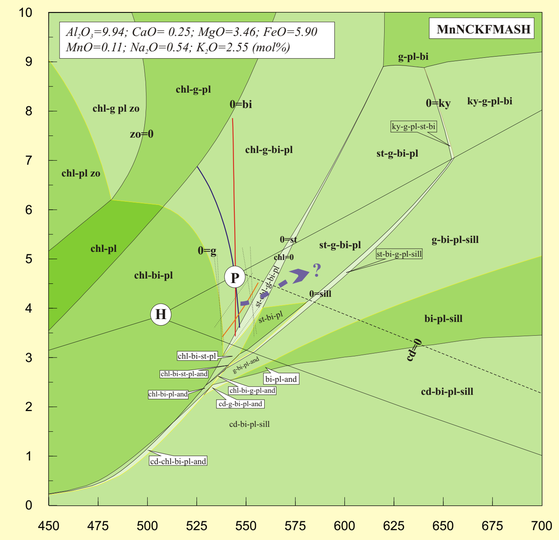


Compositional X-ray maps

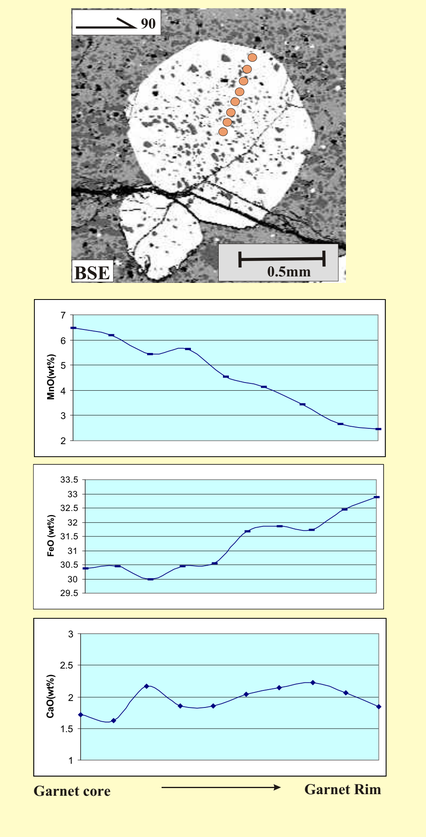


Sample No. WB-45
White Blow Formation

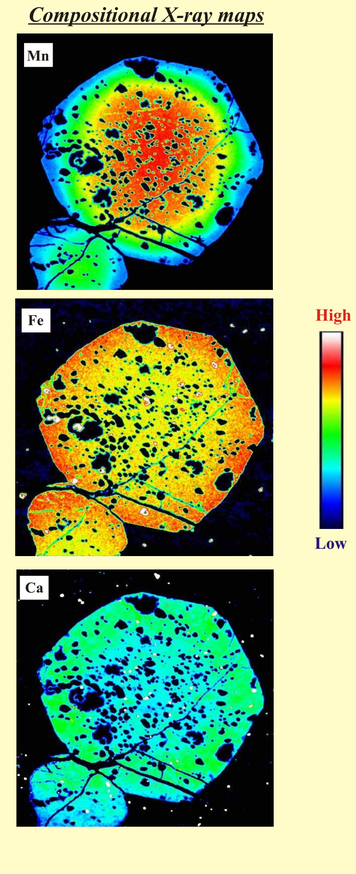




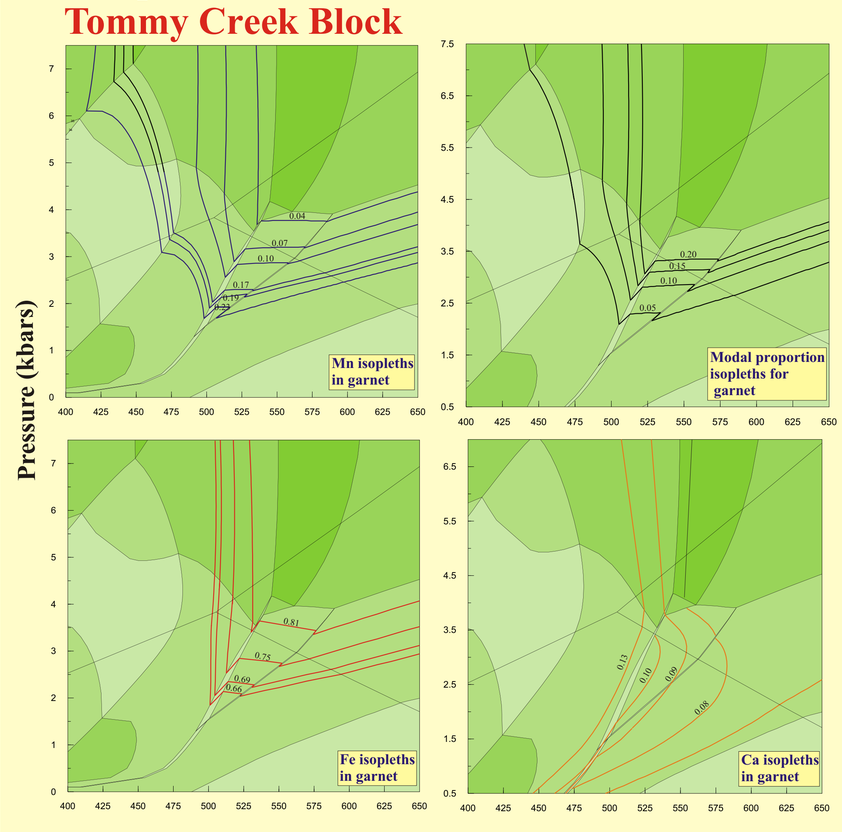
Garnet core (intersection isopleths)
T: 544-547°C
P: 3.7-4.5kbars

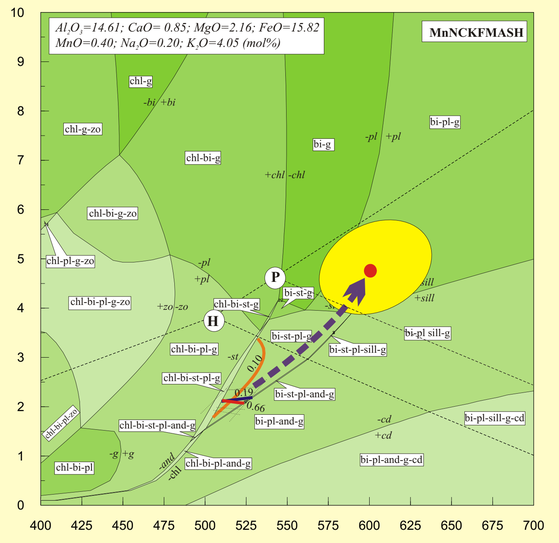


Compositional X-ray maps

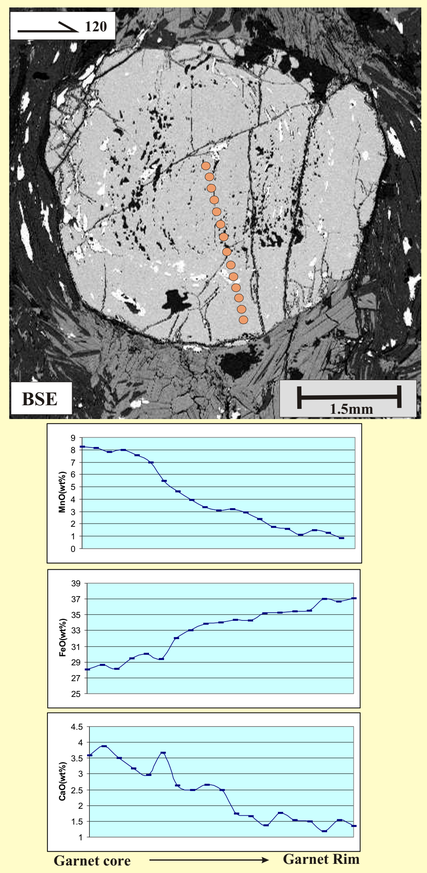


Sample No. TC-186
Tommy Creek Block





Garnet rim (Average P-T mode; Thermocalc-3.2)
T: 600 29°C
P: 4.8 1.1kbars
sigfit: 0.8
Garnet core (intersection isopleths)
T: 510-515°C
P: 2.1-2.3kbars



Compositional X-ray maps