Episodic Deformation and Metamorphism in southeastern Vermont: New Age Constraints from Electron Microprobe and SHRIMP Analysis of Monazite Inclusions in Garnet.

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Sample Locations for Microprobe Age Dating

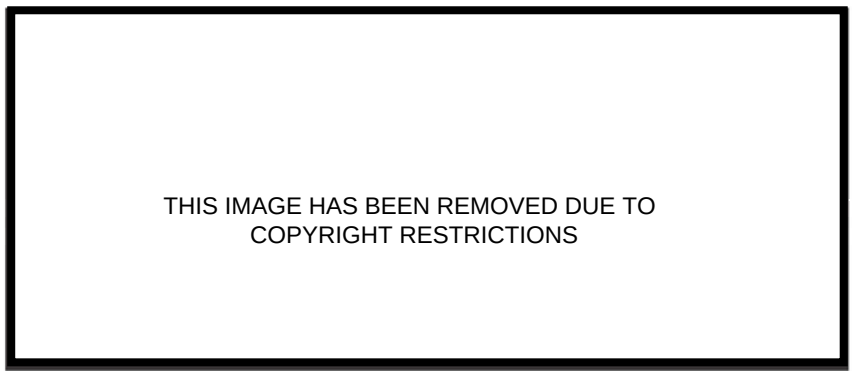

Figure 1. Geologic map of Chester and Athens domes area in southeastern Vermont, USA with sample locations used for monazite analysis. Geology after Ratcliffe (1995a,b) and Ratcliffe and Armstrong (1995,1996). Yg = Middle Proterozoic basement gneisses of the Green Mountain Massif and the core of the Chester and Athens Domes; CZh = Proterozoic to Early Cambrian Hoosac Formation including the Cavendish and Gassetts Schists; Cph = Gam brian Pinney Hollow Formation; Co = Cambrian Ottauquechee Formation; Cr = Cambrian Rowe Schists; OCs = Ordovician and Cambrian Stowe Formation; Om = Ordovician Moretown Formation; Ont = Ordovician North River Igneous Suite; Och = Ordovician Cram Hill Formation; SObmf = Silurian to Ordovician Barnard Gneiss; DSn = Devonian to Silurian Northfield Formation; DSw = Devonian and Silurian Waits River Formation. GMM = Green Mountain Massif, CD = Chester Dome, AD = Athens Dome, SH = Spring Hill. Samples V634A, V436A, V436B, and V653 are all from the Ordovician Cram Hill Formation and V240 is from the Gassetts schist within the Cambrian Hoosac Formation.

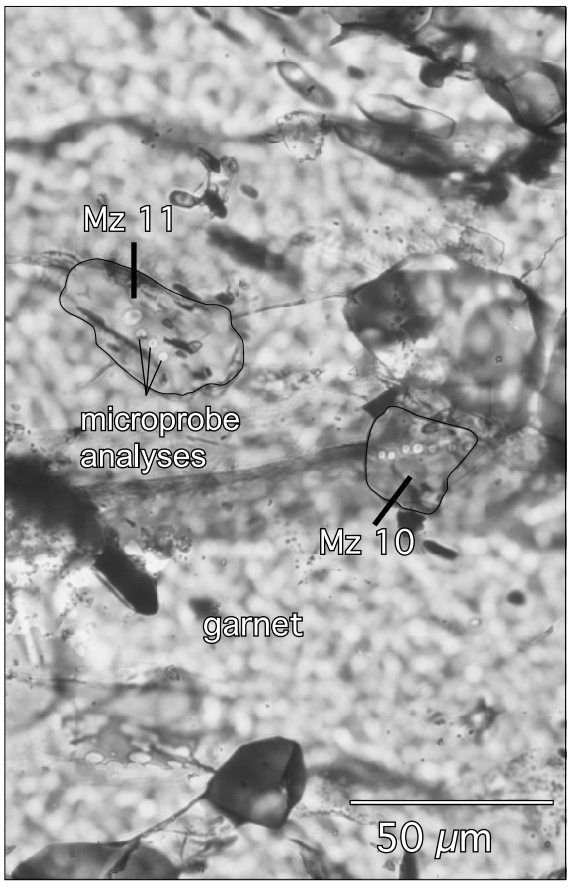

Figure 2. Transmitted light photomicrograph of a part of a garnet porphyroblast from sample V436A containing two monazite grains (Mz10 and Mz11) completely enclosed by garnet. Monazite grains have been outlined. Note that both grains have identifiable bright circles resulting from microprobe analyses. Positions of microprobe analyses were all checked by a combination of optical microscopy and BSE imaging.

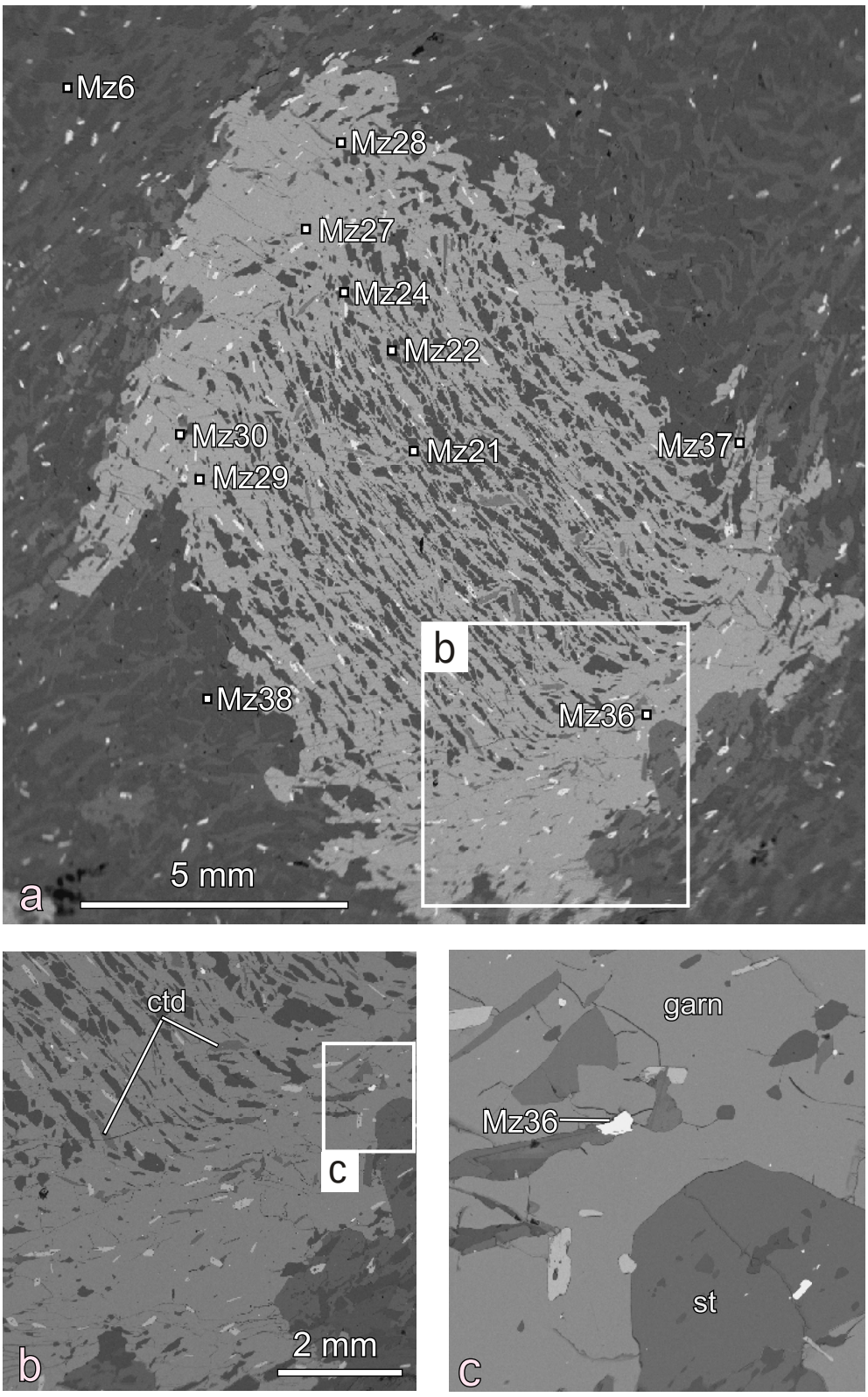

Figure 3a, b, and c. Backscattered electron (BSE) images for sample V634A, 3a) BSE image of a garnet porphyroblast with inclusion trails in the garnet core dominated by quartz with numerous monazite inclusions. 3b) BSE image of the core/rim interface of porphyroblast in 3a showing chloritoid inclusions in the core. 3c) Monazite inclusion in the garnet rim with inter-grown garnet and staurolite.

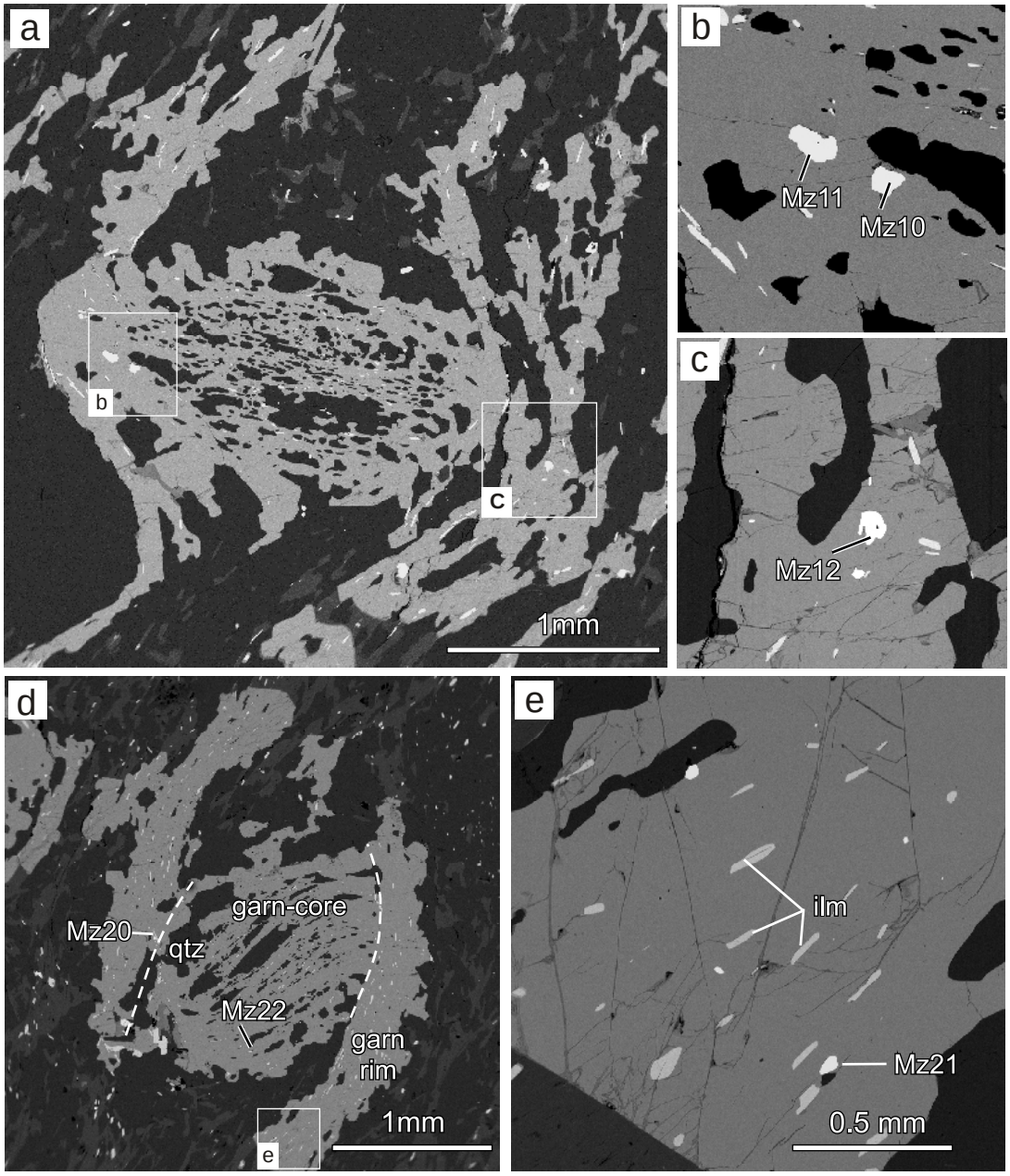

Figure 4a-e. BSE images for sample V436A. 4a) BSE of a garnet porphyroblast with three monazite inclusions; two at the edge of the garnet core (Mz10 and Mz11) in 4b and one in the garnet rim 4c (Mz12). 4d) BSE of garnet porphyroblast with sigmoidal inclusion trails in the core truncated by inclusion trails in the rim. 4e) An elongate monazite grain (Mz21) lying along the inclusion trails at the edge of the garnet rim.

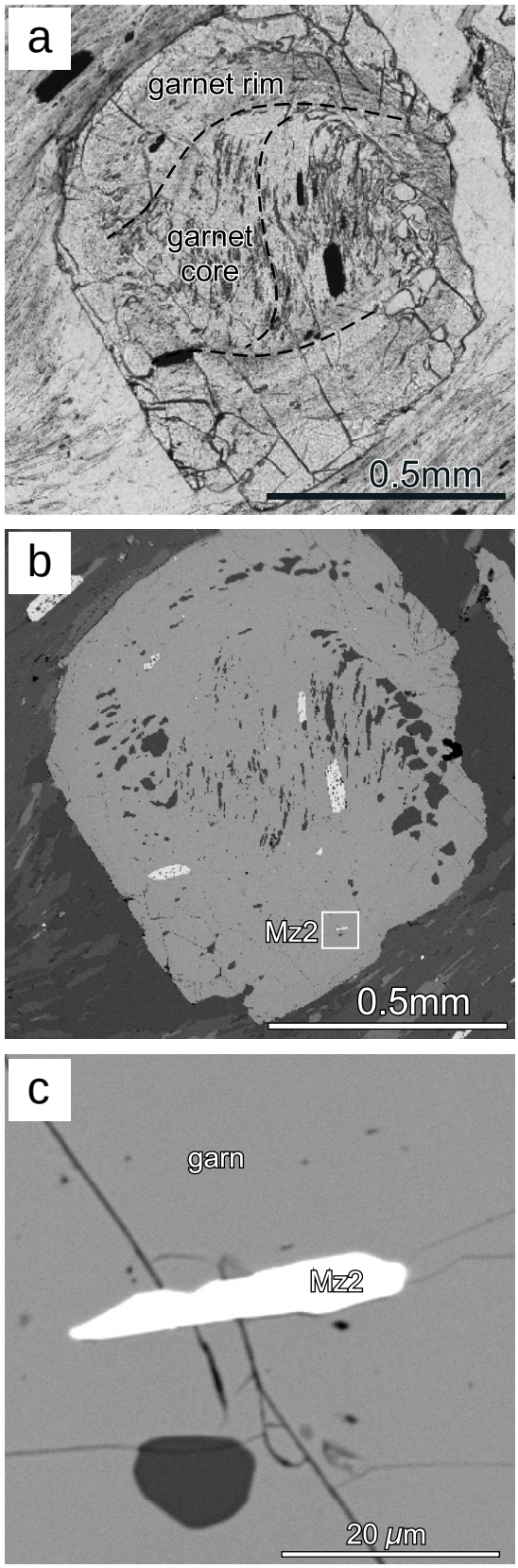

Figure 5a-c. 5a) Photomicrograph of a garnet porphyroblast from sample V436B with form lines outlining inclusion trail geometry for garnet core and rim. Orthogonal sets of inclusion trails are a common feature in garnet porphyroblasts in southeastern Vermont. 5b) BSE of garnet in 5a with single monazite, Mz2, in the rim enlarged in 5c.

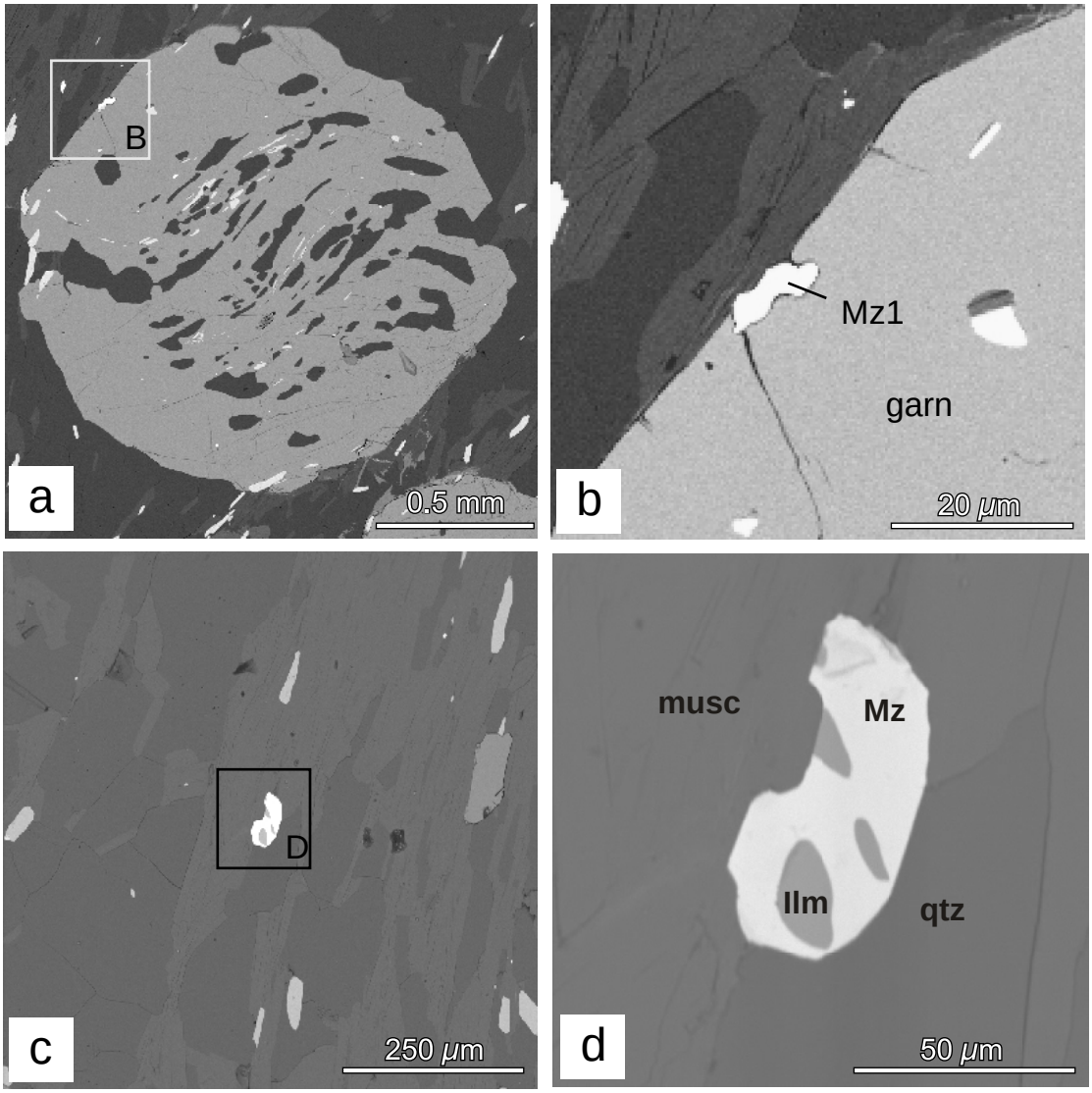

Figure 6a-d. BSE images for sample V653. 6a) BSE of garnet porphyroblast with sigmoidal inclusion trails and a single monazite inclusion at the garnet edge enlarged in 6b. 6c and d) Large monazite with ilmenite inclusions in the matrix surrounded by muscovite and quartz.

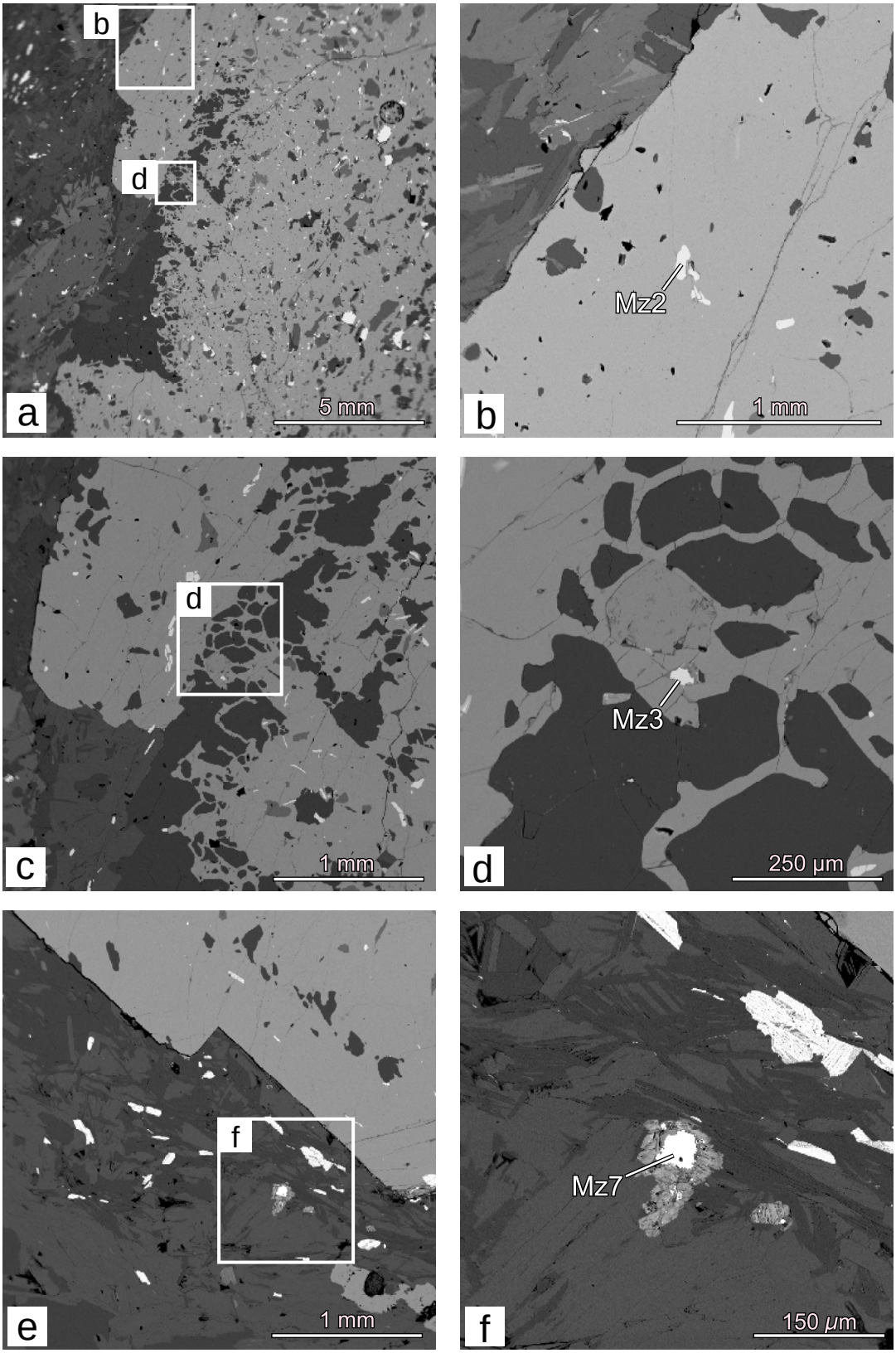

Figure 7a-f. BSE images of sample V240. 7a) BSE of part of a large garnet porphyroblast with two monazite inclusions. 7b) Monazite inclusion (Mz2) completely enclosed by garnet near garnet rim. 7c,d) Enlargement of quartz-rich area from 7a with small monazite inclusion (Mz3) further enlarged in 7d. 7e) Matrix near edge of garnet porphyroblast with matrix monazite shown. 7f) Matrix monazite (Mz7) enclosed in a symplectite of apatite and allanite.

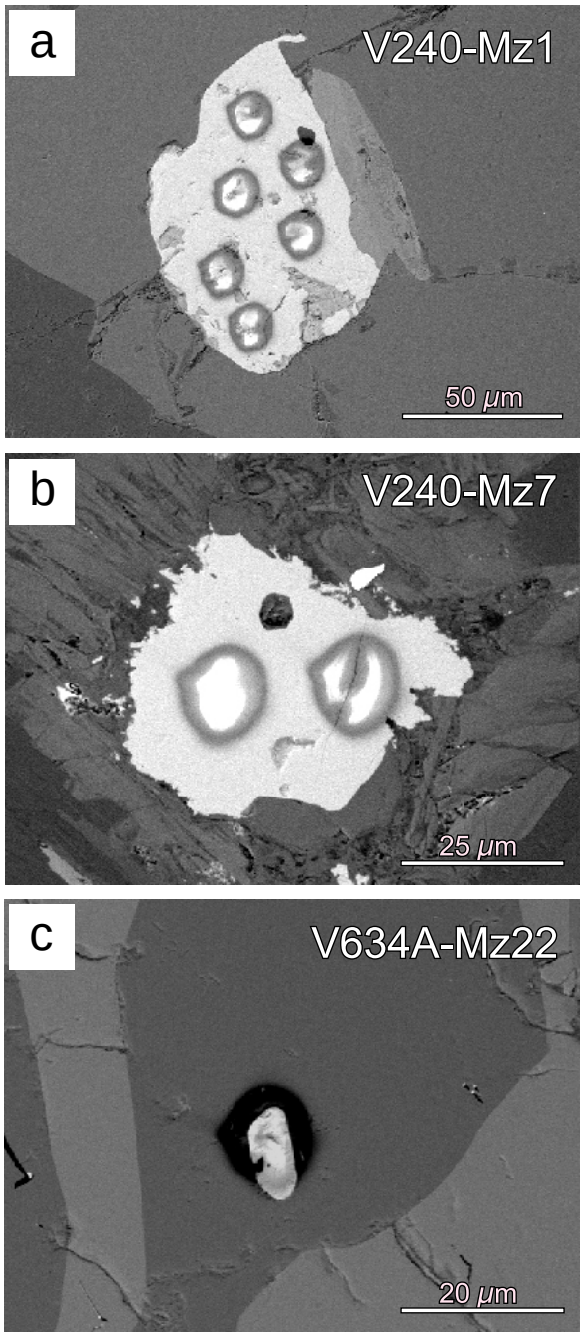

Figure 8a-c. BSE images of monazite grains that were analysed with SHRIMP showing analysis area. . 8a) V240-Mz1 is a large monazite form the garnet rim of sample V240 with 6 SHRIMP pits. 8b) V240-Mz7 is matrix monazite shown in figure 7. Note irregular edges and overgrowth of apatite and allanite. 8c) Monazite grain from sample V634A engulfed by SHRIMP pit.