Abstract: Magma flow in dykes is still not well understood; some reported magnetic fabrics are contradictory and the potential effects of exsolution and metasomatism processes on the magnetic properties are issues open to debate. Therefore, a long dyke made of segments with different thickness, which record distinct degrees of metasomatism, the Messejana-Plasencia dyke (MPD), was studied. Oriented dolerite samples were collected along several cross-sections and characterized by means of microscopy and magnetic analyses. The results obtained show that the effects of metasomatism on rock mineralogy are important, and that the metasomatic processes can greatly influence anisotropy degree and mean susceptibility only when rocks are strongly affected by metasomatism. Petrography, scanning electron microscopy (SEM) and bulk magnetic analyses show a high-temperature oxidation-exsolution event, experienced by the very early Ti-spinels, during the early stages of magma cooling, which was mostly observed in central domains of the thick dyke segments. Exsolution reduced the grain size of the magnetic carrier (multidomain to single domain transformation), thus producing composite fabrics involving inverse fabrics. These are likely responsible for a significant number of the 'abnormal' fabrics, which make the interpretation of magma flow much more complex. By choosing to use only the 'normal' fabric for magma flow determination, we have reduced by 50 per cent the number of relevant sites. In these sites, the imbrication angle of the magnetic foliation relative to dyke wall strongly suggests flow with end-members indicating vertical-dominated flow (seven sites) and horizontal-dominated flow (three sites).