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Abstract: A prominent magnetic low along an eastern portion of the Paleoproterozoic Taltson magmatic zone (TMZ) correlates mainly with the youngest granitoid in the zone, the peraluminous ca. 1936 Ma Konth granite. Flanking belts of higher magnetic intensity coincide mainly with slightly older Taltson plutonic rocks (e.g. ca. 1986 Ma Deskenatlata granodiorite, ca. 1955 Ma Slave granite) to the west and Neoarchean and/or Paleoproterozoic gneisses of the Rae Craton to the east. A prominent gravity low along a portion of the northeastern margin of the TMZ correlates mainly with the Konth granite. Modelling of east–west magnetic and gravity profiles crossing the TMZ is used to investigate the geometrical and geological significance of these signatures.

Modelling of the gravity low revealed a basin-like shape, with a maximum thickness of 14.9 km, for a composite unit of Konth–Slave magmatic suites. Magnetic modelling, the preferred technique north and south of the gravity minimum, yielded basin-like shapes for an essentially nonmagnetic Konth–Slave unit, but with much smaller maximum thicknesses of 5.0 and 6.5 km, respectively. Farther south in the TMZ, strongly magnetic units within mapped Konth and Slave granites preclude definition of a nonmagnetic Konth–Slave unit. Aside from the Slave unit, most other modelled magnetic units are generally steep and narrow and have fairly large magnetic susceptibilities. They are modelled to a depth of 6.2 km below sea level and have a steeply dipping, near-surface structural fabric extending to significant depth. Granitoids in the TMZ have previously been designated as ilmenite series or magnetite series, but modelled susceptibilities indicate that revisions to some designations may be required.

Résumé : Un important creux magnétique le long d'un segment oriental de la zone magmatique de Taltson (ZMT) du Paléoprotérozoïque est corrélé en grande partie avec le plus récent granitoïde de la zone, le syénogranite hyperalumineux de Konth, qui remonte à environ 1936 Ma. Des bandes de plus forte intensité magnétique situées de part et d'autre de ce creux coïncident en grande partie avec des roches plutoniques de la zone de Taltson un peu plus anciennes (p. ex., la granodiorite de Deskenatlata, datée à environ 1986 Ma, et le granite de Slave, daté à environ 1955 Ma) à l'ouest et avec des gneiss néoarchéens ou paléoprotérozoïques du craton de Rae à l'est. Un important creux gravimétrique est présent le long d'une partie de la marge nord-est de la ZMT et est corrélé en grande partie avec le granite de Konth. La modélisation de profils magnétiques et gravimétriques est-ouest traversant la ZMT sert à examiner la signification géométrique et géologique de ces signatures.

La modélisation du creux gravimétrique a révélé une unité composite en forme de bassin, d'une épaisseur maximale de 14,9 km, constituée des suites magmatiques de Konth et de Slave. La modélisation magnétique, la méthode privilégiée au nord et au sud du minimum gravimétrique, a révélé des formes de bassin pour une unité composite Konth-Slave essentiellement non magnétique, mais dont l'épaisseur maximale est beaucoup plus faible, soit 5,0 km au nord et 6,5 km au sud. Plus au sud dans la ZMT, des unités fortement magnétiques à l'intérieur des limites cartographiques des granites de Konth et de Slave empêchent la distinction d'une unité Konth-Slave non magnétique. Outre l'unité de Slave, la plupart des autres unités magnétiques modélisées sont généralement abruptes, étroites et présentent des susceptibilités magnétiques relativement élevées. Elles sont modélisées jusqu'à une profondeur de 6,2 km sous le niveau de la mer, et présentent une fabrique structurale fortement inclinée près de la surface qui se prolonge jusqu'à une profondeur considérable. Bien que des granitoïdes de la ZMT aient déjà été attribués à la série de l'ilménite ou à celle de la magnétite, les susceptibilités modélisées indiquent qu'une révision de certaines attributions pourrait être nécessaire.

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INTRODUCTION

The Rae Craton, northwest Canadian Shield, displays many prominent magnetic anomalies (Fig. 1) whose relationship to geology has been described by Thomas (2018a, b). Quantitative modelling of these anomalies can provide three-dimensional insight into crustal structure and possibly composition. As an example, one noteworthy anomaly is the prominent negative anomaly associated with the Paleoproterozoic Taltson magmatic zone (TMZ) and in particular with the ca. 1936 Ma peraluminous Konth granite (Bostock, 2014) that forms a large portion of the central TMZ (Fig. 2, 3).

Considering that geophysical investigations in the northern part of the TMZ are limited, there is a compelling need for further such investigations. These could provide insights into deep structure and possibly crustal composition that may have links with surface geology. Squance (1999) completed magnetic and gravity modelling for the area,

and H.H. Bostock (unpub. rept., 2012) consulted aeromagnetic and airborne radiometric maps while investigating the tectonic evolution of the TMZ.

A wealth of magnetic and gravity data for the entire northern TMZ is available in national databases maintained by the Geological Survey of Canada. These data provide maps of geophysical signatures for comparative analysis of geology at a resolution appropriate to the scale of geological maps (1:250 000, Bostock, 2014; 1:550 000, Pehrsson et al., 2014). In addition, these data are amenable to being used in quantitative modelling to create crustal sections.

Analyses of magnetic and gravity data are expected to enhance knowledge of several geological features. Objectives include definition of the depth and shape of the Konth and Slave granites (Konth–Slave composite unit); investigation of the fourfold internal division of the Konth granite (H.H. Bostock, unpub. rept., 2012); delineation of any noteworthy geological contacts or discontinuities (e.g. faults) at
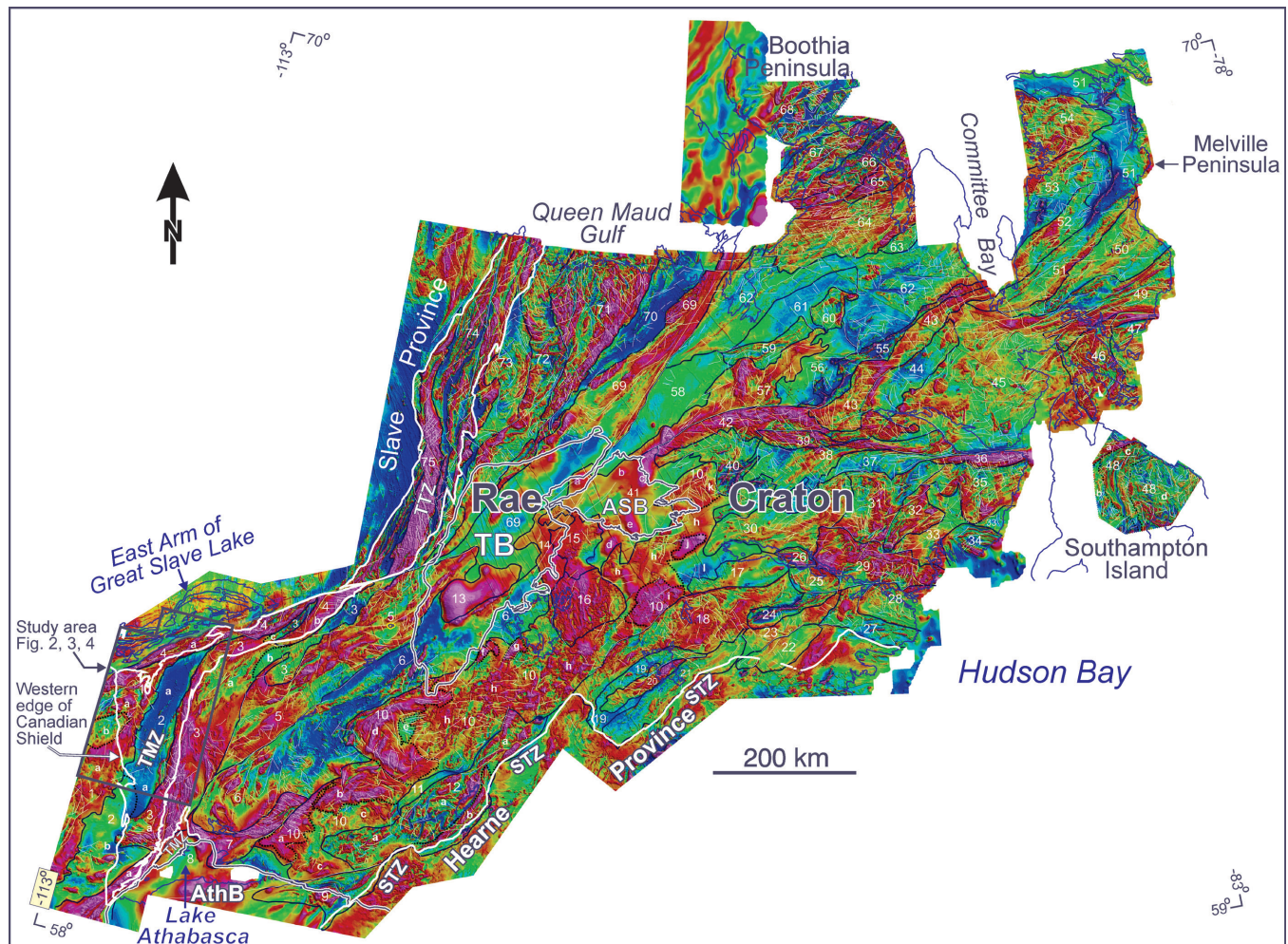
Figure 1. Map of residual total magnetic field of the Rae Craton showing boundaries of magnetic domains (numbered, e.g. 8) and subdomains (e.g. 10d) and interpreted faults (thin white lines) superposed (from Thomas, 2018a). Heavy white lines define the Snowbird tectonic zone (STZ), Taltson magmatic zone (TMZ), and Thelon tectonic zone (TTZ). Heavy white lines with an intermediate navy line define the Paleoproterozoic Thelon Basin (TB), Aberdeen Subbasin (ASB), and Athabasca Basin (AthB).

depth; determination of the attitude of shear zones; and exploration of thrust-like structures associated with shear zones. For example, McDonough et al. (2000) noted sinistral transpression with doubly vergent crustal shortening, involving a central strike-slip fault in the southern TMZ. The analyses included examination of magnetic signatures and modelling of magnetic and gravity profiles crossing the TMZ.

TALTSON MAGMATIC ZONE

The Paleoproterozoic TMZ is a north-trending plutonic complex on the southwest margin of the Rae Craton, immediately south of the Great Slave Lake shear zone (Fig. 2). The complex lies between the western edge of the Canadian Shield and Neoarchean and/or Paleoproterozoic undifferentiated mixed gneiss, granite, orthogneiss, and quartzofeldspathic migmatite (APgn, Pehrsson et al., 2014) of the Rae Craton margin to the east (Fig. 2). This marginal area was designated as Taltson basement complex (TBC) by McDonough et al. (1995) and described in more detail by McNicoll et al. (2000). McDonough et al. (2000) described the TMZ as a composite continental collisional and Andean-type magmatic orogen produced by interaction of the predominantly Archean Churchill Province (= Rae Craton) to the east and the hidden Paleoproterozoic Buffalo Head terrane to the west. The TMZ includes two main groups of plutonic rocks: those dating from 1986 to 1959 Ma and those dating from 1940 to 1930 Ma, identified as I-type and peraluminous S-type varieties, respectively (Card et al., 2014). The northern TMZ is characterized by geological units and structures (shear zones and faults) that trend predominantly northward (Fig. 2). Its central part is dominated by a unit (PTg) of the Taltson magmatic suite that includes a dominant component of peraluminous granite and lesser amounts of tonalite and quartz monzodiorite to diorite (Pehrsson et al., 2014); most of the area underlain by unit PTg was referred to as Konth granite by Bostock (2014) that has ages of 1938 to 1929 Ma. Sizable units identified as 1955 Ma Slave granites (Bostock, 2014) that include megacrystic granite and pegmatite (PTsg of Pehrsson et al., 2014) are present along all margins of the Konth granite. In the southern marginal zone, some units designated as Slave granite (Pehrsson et al., 2014) were mapped as Othikethe Falls granite by Bostock (2014).

Units of leucogranite and minor gneiss (PTgl) have a much more restricted distribution near the western and eastern margins of the TMZ (Pehrsson et al., 2014). West of longitude 112°W mainly 1986 Ma Paleoproterozoic Deskenatlata granodiorite is mapped with some mixed gneiss composed of Slave-type granite and Deskenatlata granodiorite (Bostock, 2014). The eastern margin of the TMZ is represented predominantly by Konth granite (Pehrsson et al., 2014), though Bostock (2014) assigned most of these marginal rocks to the coeval Arch Lake granite (1938 ± 3 Ma, McDonough et al., 2000) and some to the Gagnon granite (Fig. 2).

Scattered, narrow, linear, north-trending screens of Paleoproterozoic metasedimentary rocks occurring throughout the TMZ were identified as Rutledge River Basin metasedimentary rocks (Bostock, 2014), also referred to as Rutledge River assemblage (Card et al., 2014). They range in age from 2153 to 1904 Ma (Bostock and van Breemen, 1994; Bostock, 2014). Pehrsson et al. (2014) assigned most of these screens to the 2.3 to 1.92 Ga Hill Island Lake assemblage (PSH) and the 2.3 to 1.92 Ga Mama Moose complex (PsM).

East of the TMZ the area is underlain principally by Neoarchean and/or Paleoproterozoic mixed gneisses (APgn) (Pehrsson et al., 2014). Some fairly small units of the Paleoproterozoic metasedimentary Nonacho Group (PN) and Paleoproterozoic anorthosite, anorthositic gabbro, and gabbroic anorthosite (Pa) (Berrigan Lake complex of Bostock, 2014) are also present. Several essentially north-trending shear zones (Allan Lake, Gagnon, and Tazin) are mapped along the eastern margin of the TMZ and within Neoarchean and/or Paleoproterozoic gneissic rocks to the east. Along its western margin the northeast-trending Central shear zone transects the Deskenatlata granodiorite, and in the south-central TMZ the Warren shear zone (WSZ in Fig. 2) extends northwestward across the southern part of the Konth granite.

H.H. Bostock (unpub. rept., 2012) partitioned granitoid rocks of the TMZ into three plutonic suites. The earliest, comprising 1.99 to 1.96 Ga I-type granodiorites, including the voluminous 1986 Ma Deskenatlata granodiorite (Bostock, 2014), was considered correlative with continental arc rocks in the Thelon tectonic zone (TTZ) for which Card et al. (2014) reported an age range of 1986 to 1959 Ma. H.H. Bostock (unpub. rept., 2012) concluded that this early group had been emplaced diachronously from the northwest and west and extended southeastward beneath younger Taltson granitic plutons at least as far east as the Allan shear zone (Squance, 1999), and possibly beneath the TBC (Fig. 2). The succeeding age category is represented by the ca. 1955 Ma S-type ilmenite-series Slave granite that centrally intruded the earlier granodiorite (H.H. Bostock, unpub. rept., 2012). A discontinuous veneer of "Slave–Deskenatlata-metabasite-paragneiss mixed gneiss" extensively overlying the Deskenatlata granodiorite south of the Central shear zone (Fig. 2) may indicate that Slave granite overrode the granodiorite. The youngest age category includes the extensive ca. 1936 Ma Konth granite; the extensive, but narrow, ca. 1938 Ma Arch Lake granite; and the smaller ca. 1940 Ma Gagnon and ca. 1926 Ma Othikethe Falls granites (ages from Bostock, 2014).

The ca. 1936 Ma Konth batholith (Bostock and Loveridge, 1988) is an S-type, ilmenite-series granite that is the largest intrusive unit in the area. H.H. Bostock (unpub. rept., 2012) proposed that the intrusion formed in four connected north–south aligned structural segments, though a detailed rationale was not presented. From north to south, these were designated the dyke-like (D), main feeder (M), screen-line (SC), and sill-like (SL) segments (Fig. 2). The dyke-like segment is narrow, generally 4 to 8 km wide, and flanked on both

sides by the older 1955 Ma Slave granite. The main feeder (M) is a fairly large segment covering much of the northern part of the batholith. Its definition in this area, presumably, is largely based on geophysical modelling by Squance (1999), who concluded that the Deskenatlata granodiorite dips gently eastward beneath the Slave and Konth granites, attaining a maximum depth along the east margin of the Konth pluton. Correlation of the main feeder (M) with the core area of the prominent gravity low (Fig. 2; *see* Fig. 4) supports the presence of a feeder zone. The gravity low probably reflects lighter, eastward-thickening Konth granite contrasting laterally with higher density Deskenatlata granodiorite to the west and possibly higher density Neoarchean and/or Paleoproterozic mixed gneisses to the east.

Most of the southern half of the Konth batholith comprises the screen-line segment (SC), characterized by two central, north–south screen lines thought to reflect roof collapse (H.H. Bostock, unpub. rept., 2012). It is conjectured by the author that these screens are the narrow units of Hill Island Lake assemblage (Fig. 2). The southern extremity of the batholith, south of the Warren shear zone, represents the sill-like (SL) segment. Foliation in this segment indicates the presence of a nearly horizontal, southwest-trending central trough, and apparent windows into Slave granite and paragneiss suggest the absence of a subjacent feeder dyke or chamber roof, such that the Konth granite is thin and has a floor dipping shallowly northward (H.H. Bostock, unpub. rept., 2012).

MAGNETIC FIELD AND DOMAINS IN THE AREA OF THE TALTSON MAGMATIC ZONE

The northern TMZ includes parts of magnetic domains 1, 2, and 3 (Fig. 3) defined by Thomas (2018a) that strike north, in contrast to the predominantly northeast trends of magnetic domains to the east (Fig. 1). One of the most striking features of the TMZ is the prominent magnetic low defining domain 2, which contrasts strongly with the positive magnetic signatures of flanking domains 1 and 3 (Fig. 3).

Domain 4 strikes northeast, truncating the northern margins of the other domains and correlating with the Great Slave Lake shear zone.

Domain 1 is characterized by a strong positive magnetic signature correlating with the ca. 1986 Ma Deskenatlata granodiorite, ca. 1955 Ma Slave granites, small areas of Paleoproterozoic (ca. 2.3–1.92 Ga) metasedimentary sequences, and an area of mixed gneiss consisting of Slave granite and Deskenatlata granodiorite protolith (Bostock, 2014; Pehrsson et al., 2014). Within the study area, domain 1 is roughly 60 to 75 km wide, its western boundary lying beyond the extent of this study.

Central domain 2 varies in width from about 32 to 58 km and extends for about 250 km. The defining magnetic low is generally little perturbed, except for a series of narrow, north-trending linear magnetic highs exhibiting partial correlation with some of the scattered, narrow, linear metasedimentary screens of the Hill Island Lake assemblage (Pehrsson et al., 2014). Domain 2 correlates mainly with the ca. 1936 Ma peraluminous Konth granite and marginal units of peraluminous ca. 1955 Ma Slave granite. Slave granites within domain 2 generally have subdued magnetic responses that contrast with their noticeably positive responses within domain 1.

Domain 3 is rather wide, 60 to 85 km, and its eastern margin (not observed in Fig. 3) is defined by truncation of northeast-striking magnetic anomalies of domains 5 and 6 (Fig. 1). The predominantly strongly positive magnetic signature of domain 3 contrasts with a relatively weak signature over a small area of the northern part of the domain (Fig. 3) that correlates partly with units of the Paleoproterozoic metasedimentary Nonacho Group and Neoarchean and/or Paleoproterozoic mixed gneisses (Pehrsson et al., 2014). Although associated with a weak signature in this northern area, the mixed gneisses underlie a significant portion of the domain and are generally associated with strong magnetic signatures. A strong magnetic signature along the western margin of the domain correlates principally with the linear Arch Lake granite, a K-feldspar megacrystic S-type granite to syenogranite gneiss dated at 1938 Ma (McDonough et al., 2000; Bostock, 2014). The Arch Lake granite is distinguished from the Konth batholith by its magnetite-bearing-series signature.

Figure 2. Geological map of the Taltson magmatic zone (TMZ) compiled from maps by Bostock (2014) and Pehrsson et al. (2014). Names of geological units on the map are names assigned by Bostock (2014), though 'Slave granite' is a term also used by Pehrsson et al. (2014). Legends are not comprehensive and include mainly units discussed in text. Shear zones (dashed blue lines) are reproduced from a map of Bostock (2014) and figures of H.H. Bostock (unpub. rept., 2012): ALSZ, Allan shear zone; GSZ, Gagnon shear zone; TSZ, Tazin shear zone; WSZ, Warren shear zone. BLC, Berrigan Lake complex; TBC, Taltson basement complex. Magnetic domain boundaries are heavy yellow lines; domain numbers are large yellow numbers. Lines of modelled magnetic profiles 1 to 4 are plotted; gravity models were also derived along profiles 2 and 3. Heavy black lines separate structural segments of the Konth granite, defined by Bostock as dyke-like (D), main feeder (M), screen-line (SC), and sill-like (SL) (H.H. Bostock, unpub. rept., 2012); the boundary between SC and SL is not a black line, because it coincides with the WSZ. The general area of the large gravity low (BGL) is outlined by a heavy, black, dashed line, and its axis is plotted.

GRAVITY FIELD IN THE AREA OF THE TALTSON MAGMATIC ZONE

The Bouguer anomaly map of the area (Fig. 4) shows that all domains are generally associated with positive gravity signatures, though distinct negative anomalies of limited extent (**A** and **B**, Fig. 4) are present in the northern parts of domains 2 and 3, respectively. The estimated value of the background gravity field for determining the magnitude of positive or negative signatures is based on nearly identical (−57 mGal) means and medians of gravity grid values. Anomalies are generally oriented north-south in domains 1, 2, and 3, in contrast to 035° in domain 4 (Great Slave Lake shear zone). Of importance to understanding the deep structure of the Konth granite is the elongate gravity low **A** corresponding to a large area of Konth granite, whose axis (**A**, Fig. 4) traverses mainly the eastern margin of domain 2. The southern part of the Konth granite displays a distinct north–south gravity high (**D**, Fig. 4). Gravity values range from a high of about −31 mGal in the area of the East Arm of Great Slave Lake to a low of −81 mGal within the gravity low **B** situated near the northern end of domain 3. The low is approximately centred over a small (~4.5 km diameter) Paleoproterozoic granite belonging to the 2330 to 2290 Ma North Shore plutonic suite (Bethune et al., 2013; PNsg of Pehrsson et al., 2014), surrounded mainly by Neoarchean/Paleoproterozoic mixed gneisses. The gravity low **A** associated with the Konth granite descends to a minimum of −78 mGal between profiles 1 and 3. Amplitudes of anomalies **A** and **B** relative to background are −21 and −24 mGal, respectively.

A broad belt (**E**) of strong positive anomalies characterizing domain 1 correlates mainly with Deskenatlata granodiorite and Slave granite and with lesser areas of mixed gneiss comprising those rock types and the metasedimentary Hill Island Lake assemblage (Fig. 2) (Bostock, 2014; Pehrsson et al., 2014). Domain 3 correlates mainly with a generally negative gravity field; however, a discontinuous, moderately strong belt (**C**) of gravity highs is observed mainly between the Gagnon and Allan Lake shear zones in the north and on either side of the Allan Lake shear zone in the south.

MODELLING OF MAGNETIC AND GRAVITY PROFILES

The pronounced magnetic signatures in the TMZ permit three-dimensional investigation of the structure and magnetic nature of this regional tectonomagmatic zone. This three-dimensional composite was achieved by combining two-dimensional modelling of four 100 km long magnetic profiles crossing the zone (Fig. 2, 3). The correlation of magnetic signatures with mapped geology along the lines of the profiles is presented in Figures 5, 7, 8, and 9, which include a magnetic and elevation profile, a schematic geological section, and a derived model. The presence of conspicuous gravity low **A** in the northeastern part of the TMZ resulted in two of the magnetic profiles (profiles 2, 3) being positioned to cross the best developed portion of the gravity low (Fig. 4), and gravity models were also derived along these profiles.

Magnetic modelling

A critical constraint in modelling magnetic profiles is knowledge of the magnetic susceptibilities of modelled geological units. Such information was unavailable at the beginning of, and during, the study, and was difficult to obtain due to a lack of readily accessible rock samples, adding a measure of uncertainty to the modelling process. However, after a review of the manuscript pending submission for publication, a copy of Squance's (1999) thesis was obtained after belated contact with the author. It was too late to incorporate the rock property data into the study at that stage, but comments relating to the data and to Squance's (1999) models have been added where appropriate.

Notwithstanding an apparent lack of physical properties, an estimate of the potential magnitude of susceptibilities in the TMZ was obtained by examining measured magnetic susceptibilities in the TTZ (Henderson et al., 1987). Given that comparable strong magnetic signatures characterize both the TTZ and the TMZ, this provides a reasonable proxy. For instance, the principal magnetic anomaly associated with the TTZ generally attains values >500 nT, with large areas of it >1000 nT, sizable areas >1500 nT, and small areas exceptionally >2000 nT. Within the TMZ, the magnetic field over several sizable areas along its eastern margin attains >500 nT (Fig. 3), particularly in the area of the Arch Lake granite. Smaller scattered areas >500 nT are

Figure 3. Residual total magnetic field map of the area of the Taltson magmatic zone (TMZ). The map is derived from a uniform magnetic data set compiled from airborne surveys flown for Canada's Aeromagnetic Survey Program (line spacing, 805 m; mean terrain clearance, 305 m). Boundaries of magnetic domains and subdomains (from Thomas, 2018a) and geological contacts and shear zones from Figure 2 are superposed. ALSZ, Allan shear zone; GSZ, Gagnon shear zone; TSZ, Tazin shear zone; WSZ, Warren shear zone. Lines of modelled magnetic and gravity profiles 1 to 4 are plotted. OFG, Othikethe Falls granite; PN, Nonacho Group. In East Arm of Great Slave Lake, islands are labelled 'i'.

present over the Slave granite and Deskenatlata granodiorite in the western part of the TMZ, with values >1000 nT within some very small areas.

Magnetic susceptibilities measured along a 142 km long line crossing the southern extremity of the TTZ range from 10 to 86×10^{-3} SI along a relatively short section coinciding with the principal magnetic high (Henderson et al., 1987). The high ranges from about 900 to 1900 nT, considerably larger than the 500 nT value near the upper end of values in the TMZ. Nevertheless, it is conceivable that rocks within the TMZ potentially have susceptibilities of the order of tens $\times 10^{-3}$ SI.

A related shortcoming in modelling is the absence of knowledge of remanent magnetizations within geological units. Consequently, magnetizations in this study are assumed to be induced solely by the Earth's magnetic field. Even when susceptibility information is available, the depth of a steep sheet-like unit remains uncertain, as further deepening of the base, once a critical depth is attained, makes a negligible contribution to the modelled magnetic signature. The goodness of fit between an observed magnetic profile and a model profile can be numerically evaluated in terms of the root mean square error (RMSE). However, smaller perturbations along a profile are often not modelled but contribute to the RMSE, diminishing its usefulness, and thus visual goodness of fit is adopted here.

Gravity modelling

Density information is a principal constraint in gravity modelling. A limited amount of density information is provided by archived measurements on rock samples collected during gravity surveys, and Squance (1999) also presented density data. Gravity survey samples were obtained from 32 sites on the Konth granite; of these samples, most were from domain 2 (23) and a few were from marginal areas of domain 1 (3) and domain 3 (6). About half of the samples were identified as granite; others, variously as syenite, acid gneiss, or quartzite. These 32 samples yielded a mean density of 2611 ± 27 kg/m³. Gravity survey samples were also obtained from 33 sites on the Slave granite; of those samples, most were obtained from domain 2 (19) and some were from adjacent marginal zones of domain 1 (9) and domain 3 (5), variously described as granite, syenite, acid gneiss, and quartzite. These 33 samples yielded a mean density of 2611 ± 34 kg/m³, identical to that for Konth granites. The mean density of all 65 samples of these two granites is 2611 ± 30 kg/m³. Thus, these two granites are treated as a

single density unit in modelling. Squance (1999) also treated the Konth and Slave granites as a single unit, including as well the Arch Lake granite and TBC because of similarity in their densities (2650, 2630, 2640, and 2630×10^{-3} kg/m³, respectively). The mean density for 42 samples of these various rocks is 2634 kg/m³, slightly higher than the mean value for the gravity survey samples.

Only 19 measurements on samples from the Neoarchean/Paleoproterozoic undifferentiated mixed gneisses within domain 3 were available for estimating the mean density of country rocks in the TBC. Rock types included metamorphic, metasedimentary, and igneous varieties, and they yielded a mean density of 2686 ± 56 kg/m³. The Nonacho Group covers a large area within these gneisses east of the TMZ within domain 3, but underlies only the eastern extremities of profiles 1, 2, and 3 (Fig. 2). Twenty density measurements on samples from the group, including some east of the study area, yielded a mean of 2674 ± 37 kg/m³. Most samples were quartzite; a much smaller number of samples were acid gneiss, slate, schist, and mafic volcanic rocks; and only single samples were gabbro, mudstone, or greywacke. Modelling was initiated with an assigned density of 2611 kg/m³ for the Konth–Slave granite unit and 2686 kg/m³ for the country rocks.

Profile 1: magnetic modelling

Magnetic profile 1 (Fig. 5a) is derived along an east–west line crossing the TMZ near its northern end (Fig. 2, 3). The profile provides details of individual highs and lows within positive signatures that are not so apparent within the magnetic map. Values along the profile range from about +860 to −360 nT. Domain 1 is underlain mainly by early Paleoproterozoic (~2.3–1.92 Ga) metasedimentary rocks and a unit of ~1955 Ma Slave granite; it is also underlain by a narrow unit of Neoarchean and/or Paleoproterozoic mafic and ultramafic rocks (Pehrsson et al., 2014) (Fig. 5c). The domain is associated with a broad, generally slightly perturbed magnetic high typically attaining values from about 350 to 140 nT and including a single, prominent, narrow magnetic high reaching 450 nT near the western margin of the Slave granite.

Domain 2 coincides mainly with Konth granite in the west and Slave granites in the east. The magnetic field, which is fairly flat and little perturbed across the central part

Figure 4. Bouguer gravity anomaly map derived from data in the Canadian Gravity Database. The average spacing between gravity measurements is roughly 12 km. Geological contacts (fine black lines) from Figure 2 and magnetic domains (heavy navy lines) identified by large pink labels are superposed. Selected geological units are labelled in dark text: APgn, Neoarchean/Paleoproterozoic undifferentiated mixed gneiss; PN, Nonacho Group; PSH, Hill Island Lake assemblage; SG, Slave granite. PTg (red) indicates units of Slave granite defined by Pehrsson et al. (2014). ALSZ, Allan shear zone; GSZ, Gagnon shear zone; TSZ, Tazin shear zone; WSZ, Warren shear zone. Belts of gravity high (red text): C, D, E; gravity lows (white text): A, B. In East Arm of Great Slave Lake, islands are labelled 'i'.
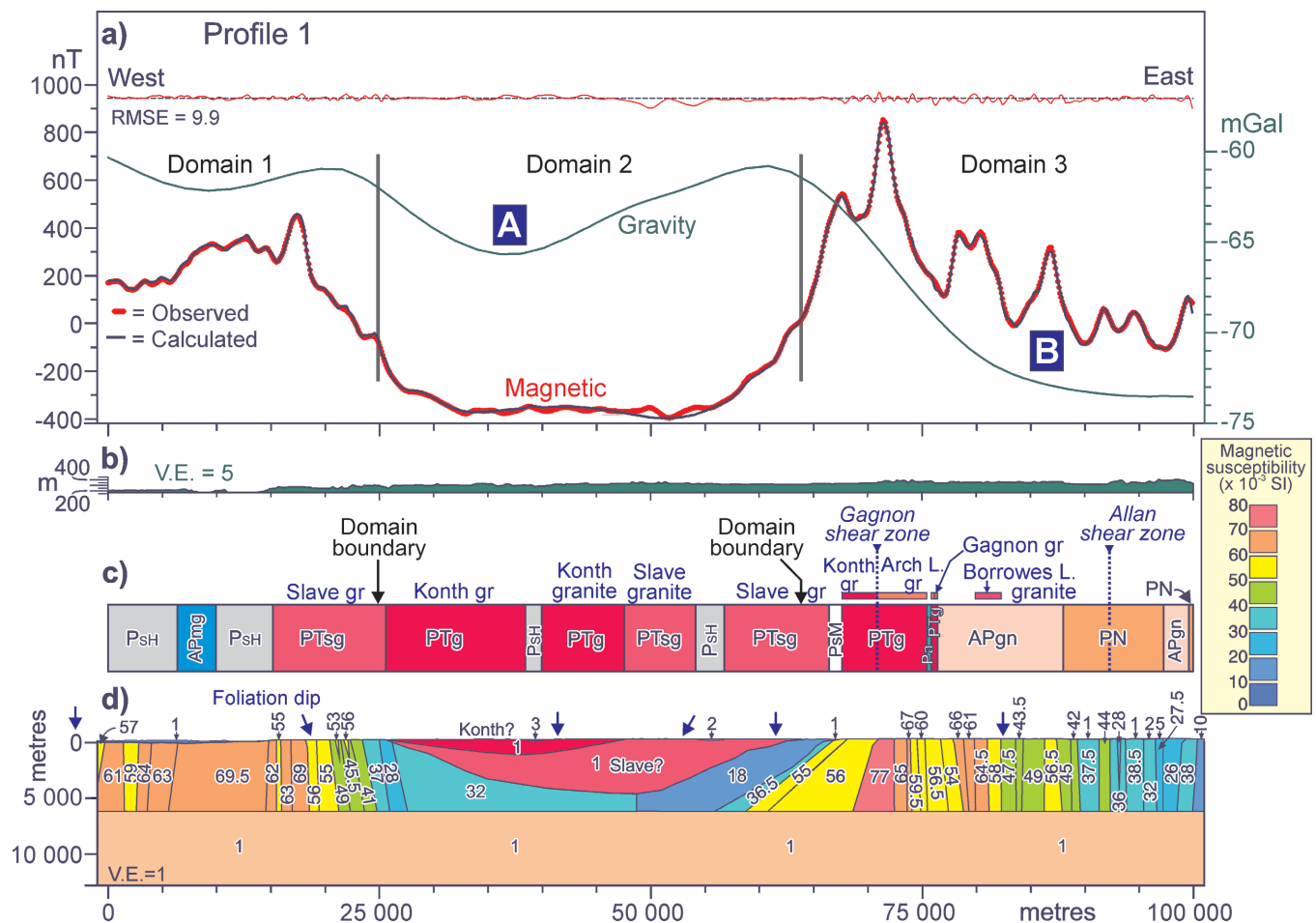
Figure 5. a) Observed and calculated (model) magnetic profiles and gravity profile along line of profile 1. A, B on gravity profile denote positions of gravity lows A and B (*see* Fig. 4 for location). Magnetic domains (Fig. 3) are delineated. **b)** Elevation profile; V.E., vertical exaggeration. **c)** Schematic geological section (vertical contacts are arbitrary) based on Pehrsson et al. (2014). *See* legend in Figure 2 for explanation of labels; labels in blue are names attributed to Bostock (2014); gr, granite; L., lake. **d)** Magnetic model; foliation dips based on Berman and Bostock (1997, their Fig. 3). Modelled magnetic units are colour coded according to the size of the magnetic susceptibility (Konth and Slave units excepted), the values of which are plotted. Boundary between the Konth and Slave units is arbitrary and based on mimicking the shape of the base of the Slave unit.

of the domain, has a general level of about −360 nT, but it rises noticeably in both marginal areas of the domain toward the flanking domains.

A relatively broad unit of Neoarchean and/or Paleoproterozoic mixed gneisses and of metasedimentary rocks of the Nonacho Group, and a narrow unit of Konth granite and of Arch Lake granite form most of the crust coinciding with domain 3. The domain is characterized by the most variable magnetic field along the profile, showing several prominent peaks separated by distinct lows. The two strongest peaks coincide with a unit of Taltson magmatic suite (PTg) (Pehrsson et al., 2014), mapped by Bostock (2014) as comprising a unit of Konth granite and a unit of Arch Lake granite, separated by the Gagnon shear zone (Fig. 5c). The stronger peak (860 nT) coincides with the Arch Lake granite, and the other straddles the boundary between the Konth granite and a narrow unit of early

Proterozoic metasedimentary rocks (PsM) belonging to the Mama Moose complex to the west. Prominent peaks farther east fall variously on units of Neoarchean/Proterozoic mixed gneisses or Nonacho Group. A small granitic body, the 2436 ± 12 Ma Borrowes Lake granite, mapped by Bostock (2014) within the unit of mixed gneisses, partly coincides with a strong magnetic peak.

The modelling process was somewhat intuitive, commencing by modelling the largest peak in the eastern half of the profile and adjacent portions and progressively expanding the model, adding many magnetic units in the process. For simplicity, bases of all units were ultimately arbitrarily set at one depth based on depths initially modelled on the eastern side of the model. This depth was 6200 m below sea level (b.s.l.), or roughly 6570 m below ground surface (Fig. 5d). Changing the depth by ±500 m resulted in small increases in RMSE, from 13.03 to 26.3 (−500 m) or to 34.8 (+500 m).

Hence, for the modelled susceptibilities (Fig. 5d), the depth of 6200 m b.s.l. is considered realistic. The crust below 6200 m b.s.l. is regarded as 'background' crust and was arbitrarily assigned a susceptibility of 1×10^{-3} SI, though this could vary from roughly 1 to 50×10^{-3} SI without manifestly changing the magnetic signature of the model. The important point is that it has a uniform susceptibility.

The strong variation in magnetic signature along the eastern portion of the profile dictated the use of steep-sided magnetic units in the model to replicate the steep slopes of alternating magnetic highs and lows. A sketch map of foliation patterns (Berman and Bostock, 1997, their Fig. 3) displays generally steep foliations (60°–90°) throughout the TMZ and Neoarchean/Paleoproterozoic mixed gneisses to the east. Gentler foliation dips (35° eastward) are observed only along the western margin of the TMZ, just north of the Warren shear zone. Replication was also aided by sizable susceptibility contrasts between some units: several contrasts were in the range 8 to 21×10^{-3} SI. Several were also $\leq 3.5 \times 10^{-3}$ SI, possibly reflecting a gradational change in susceptibility rather than a distinct contact. Unit susceptibilities within the eastern portion of the model (domain 3) are large, most ranging from 36 to 77×10^{-3} SI. These are considered viable values, given the measured susceptibilities (10–86×10^{-3} SI) for strongly magnetic rocks in the TTZ (Henderson et al., 1987).

East of the Gagnon shear zone, all magnetic units are nearly vertical. West of the zone, in contrast, four units are noticeable for their gentle dips: contacts dip westward at angles of 43°, 39°, and 30°. The eastern contact of the easternmost unit dips 74° westward from the Gagnon shear zone, indicating that the shear zone may dip at this angle. Collectively, this group of units may indicate a zone of eastward-verging thrusting. A pattern of narrow and steep-sided units, as modelled within domain 3, is derived on the west side of the modelled section, across domain 1, and susceptibilities fall within a similar range, 37 to 69.5×10^{-3} SI.

The configuration of units within domain 2, dominated by two broad, flat-lying basin-like units underlain by broad basal units (Fig. 5d), contrasts strongly with the steep forms of those within neighbouring domains. The basin-like units constitute a single low magnetic susceptibility (1×10^{-3} SI) composite unit of Konth and Slave granites having a maximum thickness of 4900 m. The rationale for assigning so low a susceptibility to the granites is their correspondence with the lowest magnetic field in the region, indicating that they are weakly magnetic. This conclusion is supported by 33 and 49 susceptibility measurements made on samples of Slave and Konth granite, respectively, that are $\leq 1.2 \times 10^{-3}$ SI (Squance, 1999). An arbitrary contact has been drawn mimicking the shape of the base of the composite unit to subdivide it into Konth and Slave components. The upper, basin-like unit of Konth granite has a maximum thickness of about 1300 m. The basin-like shape of the Konth–Slave unit modelled along profile 1 is also modelled along profiles 2 and 3. Along profile 2 (*see* Fig. 6d, 7d), basin depth is

considerably enhanced, as here it attains a maximum depth, and though an overall basin-like form is apparent along profile 3 (*see* Fig. 8d), the upper portion contains concentrations of sizable xenoliths. The section of Konth granite traversed by profile 1 is within the main feeder segment of the granite (**M**, Fig. 2) (as defined by H.H. Bostock, unpub. rept., 2012), but its modelled thin basin-like configuration is not consistent with the presence of a feeder zone that presumably would have a steep, plug-like form. This apparent absence may be explained by the position of the profile line close to the northern margin of the feeder segment, where it is conceivably thin. The narrow belt of Konth granite between flanking units of Slave granite immediately north of profile 1 was designated a dyke-like segment (**D**, Fig. 2) of Konth granite (H.H. Bostock, unpub. rept., 2012), but this attribution is debatable. The relatively shallow modelled Konth–Slave granite with its basin-like geometry, the narrow width of the dyke-like segment, and the presence of a small enclave of Slave granite at the contact between the main feeder and dyke-like segment may reflect a local deeper level of erosion that eliminated much of the Konth granite and exposed underlying Slave granite. The dyke-like segment thus may have the form of a narrow, shallow trough.

Moderately strong positive gravity signatures are associated with both units of Slave granite flanking the dyke-like segment (**D**) of the Konth granite; these gravity signatures bridge a southern portion of the segment (Fig. 4). The positive signature over the eastern unit is captured in profile format in Figure 5a. Density information predicts that the Slave granite should generate a relatively negative gravity signature; thus, it is concluded the granite in this area is quite thin and that the positive signature is attributed to metasedimentary Hill Island Lake assemblage rocks and Neoarchean/Paleoproterozoic mixed gneisses within and below the granite, small units of which are mapped within the granite (Fig. 2).

Along profile 1 a gravity low, about 5 mGal in amplitude (**A**, Fig. 5a), displays moderate correlation with the magnetically modelled Konth–Slave granitic unit, though its nadir is 12 km west of the thickest part (4900 m) of the unit (Fig. 5d), where it is 3800 m thick. Eastward the profile becomes progressively more positive over the eastern, thicker part of the granitic unit, suggesting that this increase is related to high-density crust beneath the unit. Magnetically, crust below the unit has been modelled mainly as two broad units having moderately high susceptibilities. Their bases are at 6200 m b.s.l., and their upper surfaces coincide with the base of the Konth–Slave unit.

The Konth and Slave granites are described as S-type ilmenite-series granites (Bostock, 2014), consistent with their general correlation with the regional magnetic low defining magnetic domain 2. However, the magnetic field increases appreciably eastward across the eastern marginal unit of Slave granite and the adjacent unit of Konth granite along the western margin of domain 3 (Fig. 5a). The increase at the eastern margin of domain 2 has been modelled in terms of a group of west-dipping units tentatively

viewed as an east-verging thrust package. At surface the units project into Slave and Konth granite and the metasedimentary Mama Moose complex. The easternmost unit is in contact with an adjacent unit of Arch Lake granite east of the Gagnon shear zone. Large susceptibilities modelled for the Arch Lake unit ($60–77 × 10^{-3}$ SI) are consistent with its magnetite-series character, though the unit is mineralogically similar to the Konth granite (H.H. Bostock, unpub. rept., 2012). Large susceptibilities ranging from 18 to $56 × 10^{-3}$ SI are also modelled for units of the potential thrust package, effectively categorizing the component granitic rocks as magnetite series if Ishihara et al.'s (2000) susceptibility of $3 × 10^{-3}$ SI is accepted as the boundary between ilmenite-series and magnetite-series granitic rocks. A sharp westward increase in the magnetic field across the unit of Slave granite along the eastern margin of domain 1 has been modelled in similar fashion as a series of narrow units having large susceptibilities ($28–69 × 10^{-3}$ SI), but these units are invariably very steep.

Attribution of these described parts of the Konth and Slave granites as magnetite-series granites would be invalidated if the modelled units included large amounts of metasedimentary xenoliths. Such xenolith-rich units have been modelled along other profiles. The Slave unit in domain 1 is flanked to the west by units of metasedimentary Hill Island Lake assemblage and a unit of mafic gneiss and other mafic rocks. These were modelled as a weakly magnetic surface veneer of rocks, but alternatively they could descend to greater depth and be represented by the displayed underlying high-susceptibility modelled units (Fig. 5d). Occurrences of Hill Island Lake assemblage elsewhere and of Mama Moose complex and Nonacho Group have also been modelled as thin veneers having a susceptibility of $1 × 10^{-3}$ SI. However, modelling of the narrow unit of Mama Moose complex near the western margin of domain 3 suggests that the complex has the potential to be strongly magnetic; Culshaw (1984) noted that paragneiss of the complex contains abundant magnetite.

Profile 2: gravity and magnetic modelling

Profile 2 (Fig. 2, 3, 4) crosses the most intense part of gravity low **A**, which is situated mainly on the Konth granite. Gravity modelling was completed first, because the longer wavelength of gravity anomalies compared to that of magnetic anomalies allows definition of larger scale geological units along the profile, refinement of which has been achieved by subsequent magnetic modelling.

Gravity modelling

Domain 1, underlain principally by Slave granite and metasedimentary rocks, is characterized by a virtually flat gravity field corresponding to gravity high **E** (Fig. 6a, c). The field descends eastward into gravity low **A** within domain 2, centred on a broad unit of Konth granite, before rising to define a broad gravity high, **C**, within domain 3. This high correlates mainly with Neoarchean/Proterozoic mixed gneisses and units of the Nonacho Group and lesser developments of granite and anorthositic-gabbroic rocks of the Berrigan Lake complex (Fig. 6c). Gravity modelling assumed initial densities of 2611 and 2686 kg/m³ for the Konth–Slave granite unit and country rocks, respectively. Country rocks were considered to form one unit spanning the three magnetic domains and extending to an arbitrary depth of 22 km. As modelling proceeded, it transpired that the country rocks required division into three units having different densities (Fig. 6d). Appropriately, the unit designated 'central block,' partly coincident with Neoarchean/Paleoproterozoic undifferentiated mixed gneiss east of the Konth–Slave granitic unit, was assigned a density of 2686 kg/m³, the mean density of rock samples from this general area. Ultimately, densities of 2691 and 2655 g/km³ were accepted for the western and eastern crustal blocks, respectively, and the central block density was slightly modified to 2685 kg/m³.

One 'constraint' in deriving a model for the Konth–Slave granite unit was the location of the contact between the unit and the Deskenatlata granodiorite approximately 8500 m west of the west end of profile 2. This constraint helped determine where the zero (i.e. background) value for the negative gravity effect of the granite was situated. From here, the granite unit was initially thickened, then slightly thinned eastward, and eventually terminated at the Gagnon shear zone. The resultant granitic unit has a deep central trough descending to a depth of 14.9 km near the centre of the Konth granite, and it thins dramatically on either flank, generally to less than 3 km (Fig. 6d). The western flank of the unit is more extensive, beginning well within the Konth granite and continuing westward beyond the end of the profile. Squance (1999) produced a similar gravity model along a subparallel profile roughly 6 km to the south in which the trough attained a virtually identical depth of 14.3 km. The troughs in both models are virtually cospatial, and the thin western flanks of the Konth–Slave unit are similar. Much of the western block in the model shown in Figure 6d is portrayed as Deskenatlata granite by Squance (1999), who reported a mean density of 2690 kg/m³ for the granite. In a companion magnetic model, the central trough is reasonably cospatial with that of the gravity model but is noticeably wider, extending between roughly 10 and 20 km farther west, depending on depth. Its maximum depth of 13 km is similar, though displaced some 10 km westward (Squance, 1999).

The central block of country rocks is bounded by largely near-vertical contacts on either side, though they dip gently near the surface, where the block is represented by units of Berrigan Lake complex and Neoarchean/Paleoproterozoic undifferentiated mixed gneiss having mean densities of 2800 kg/m³ (11 measurements) and 2648 kg/m³ (only 1 measurement), respectively (Squance, 1999); this area of mixed gneiss is referred to as the Berrigan fault block. These two
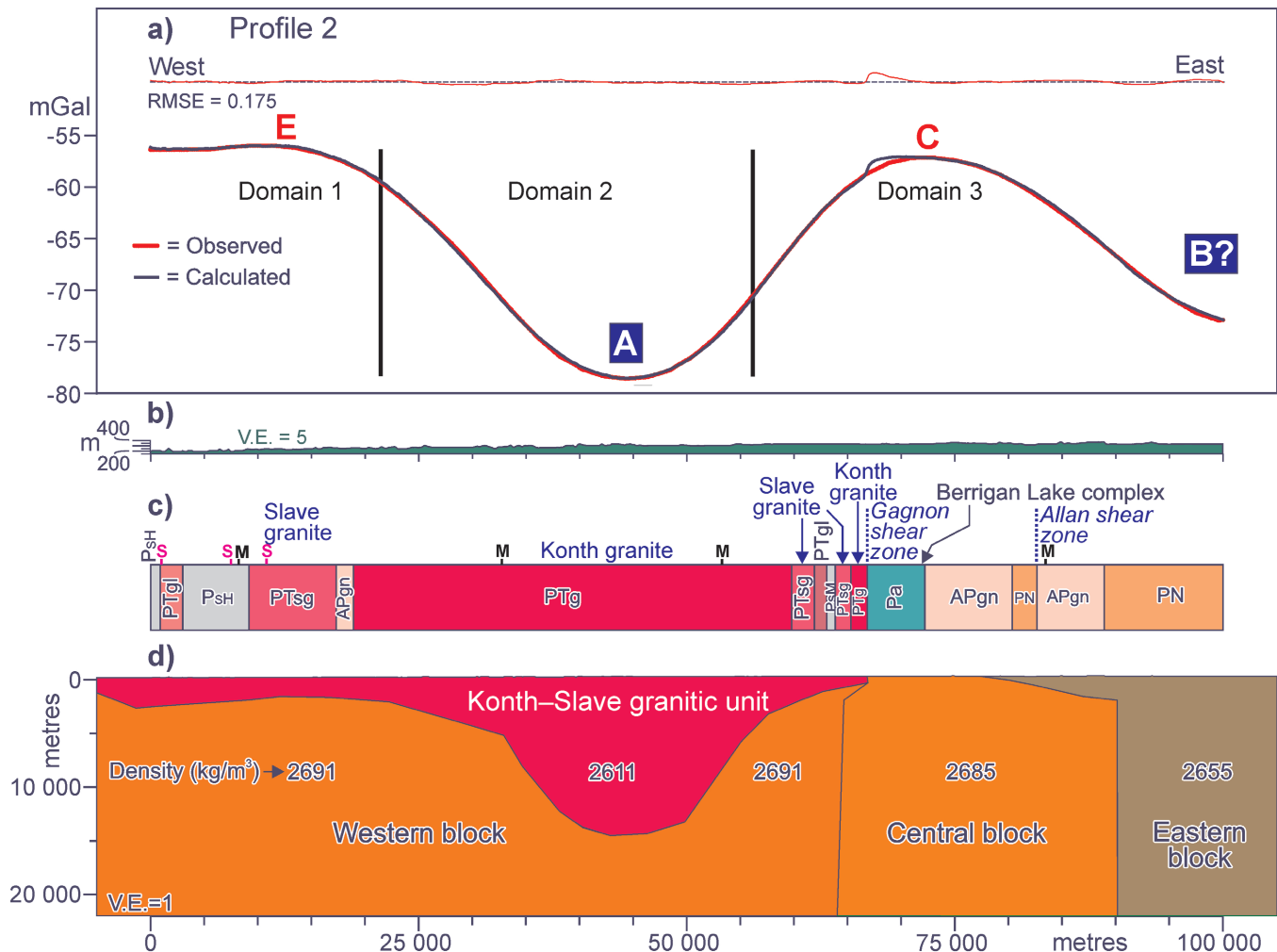
Figure 6. a) Observed and calculated (model) gravity profiles along line of profile 2. A, C, E are gravity anomalies outlined in Figure 4; B?, possible extension of anomaly B to this profile. Magnetic domains (Fig. 3) are delineated. **b)** Elevation profile; V.E., vertical exaggeration. **c)** Schematic geological section (vertical contacts are arbitrary) based on Pehrsson et al. (2014). *See* legend in Figure 2 for explanation of labels; labels in blue are names attributed to Bostock (2014). S, Sparrow diabase dyke; M, Mackenzie diabase/gabbro dyke. **d)** Gravity model.

units were not differentiated into separate density units for modelling, because they are narrow and resolution of the gravity data does not distinguish related signatures.

The density of the central block is lower than that of the western block, partly because of the narrowness of the related gravity high **C** within domain 3, which shares a common flank with a low (**B?**) at the east end of the profile. The descent from this gravity high into the gravity low results in a requirement to lower the density of the eastern block to 2655 kg/m³.

The reason for the decrease in density from the central block to the eastern one is not apparent in the mapped surface rocks, which east of the Berrigan Lake complex are dominated by Neoarchean/Paleoproterozoic undifferentiated mixed gneiss covered in places by the metasedimentary

Nonacho Group (Fig. 2). A geological section crossing the Nonacho Group in the eastern part of the area (van Breemen and Aspler, 1994) displays the group attaining thicknesses of 7 to 9.5 km in the deepest parts of various generally faulted V-shaped subbasins. An extensive continuous layer of Nonacho Group of similar thickness, apparently, is not present. The mean density of 20 samples including quartzite, slate, schist, greywacke, acid gneiss, mafic volcanic rocks, and gabbro from the Nonacho Group is 2674 ± 37 kg/m³, moderately higher than the 2655 kg/m³ mean density derived for the eastern block.

A buried granitic intrusion linked to the Paleoproterozoic North Shore pluton (PNsg) and near the centre of gravity low **B** (Fig. 4) may contribute to the low over the eastern block. The low is incompletely outlined in Figure 4, but it appears to continue southward into the vicinity of the end of

profile 2. Its amplitude diminishes significantly in this area, but its values remain fairly low, and the presence of a buried granitic body (or bodies) is a reasonable possibility.

Magnetic modelling

Magnetic profile 2 (Fig. 7) displays the same characteristics as other magnetic profiles: elevated values over domains 1 and 3; and a subdued, little-perturbed field over domain 2. Several alternating lows and highs characterize domain 3. Consistent with the approach for other models, a lower depth of 6200 m b.s.l. was initially adopted for the base of all magnetic units. Many of the steep, narrow units in

models of profiles 1, 3, and 4 extended downward from the surface within granitic units of the TMZ, but the termination of the granitic components at depth could not be determined. The units probably represent a composite of granite (upper portions) and country rocks (lower portions). The gravity model for profile 2 (Fig. 6) probably provides a better estimate of the possible depth of granitic components. During the development of the magnetic model (Fig. 7), magnetic units delineated within the gravity-derived Konth–Slave granitic unit were terminated at the base of this granitic unit, and susceptibility values with two exceptions, were deliberately limited to less than 120×10^{-3} SI, the maximum value derived in models for other profiles. Because of the shallow
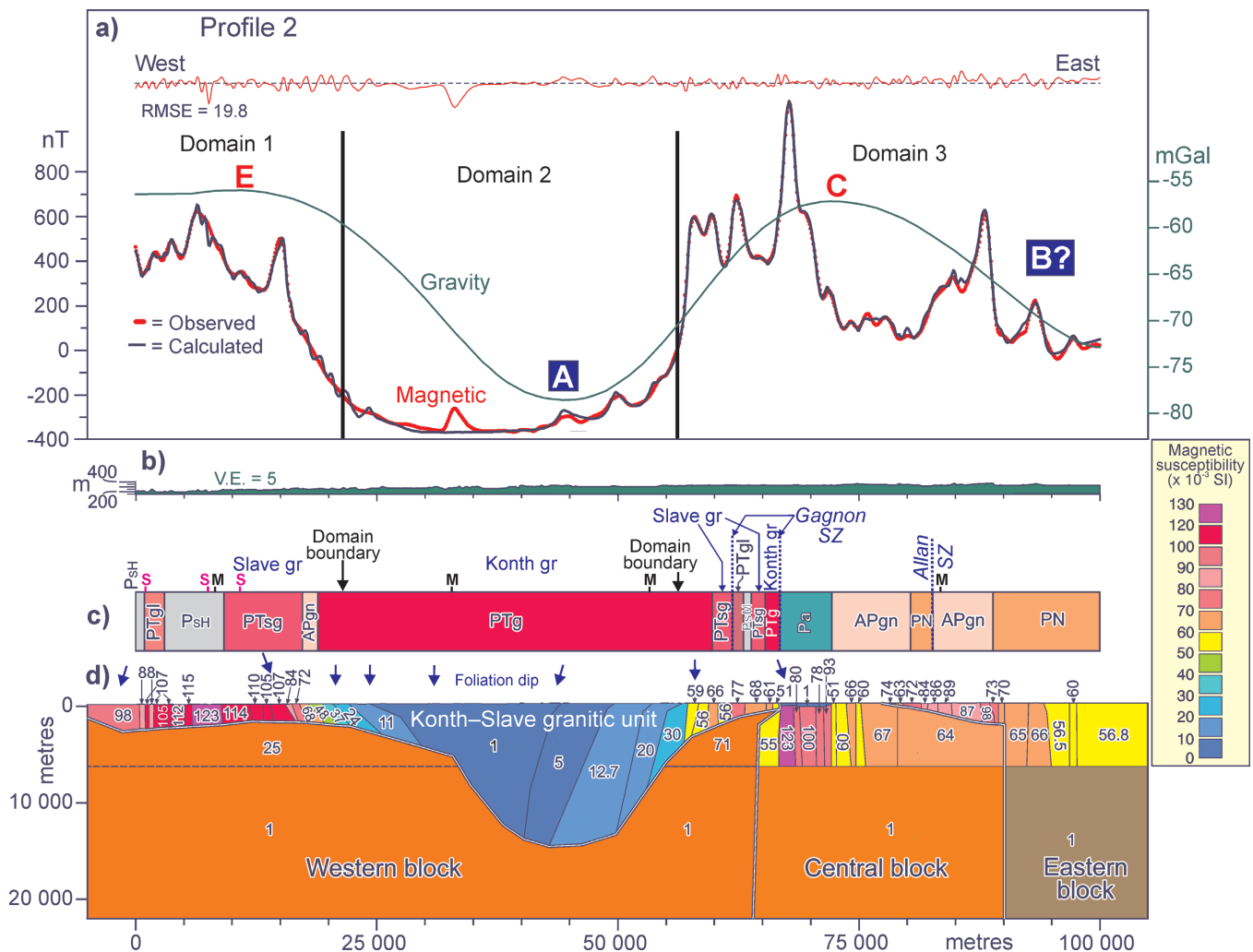
Figure 7. a) Observed and calculated (model) magnetic profiles and gravity profile along line of profile 2. A, C, E on gravity profile denote positions of gravity anomalies (*see* Fig. 4 for locations); B?, possible extension of anomaly B to this profile. Magnetic domains (Fig. 3) are delineated. **b)** Elevation profile; V.E., vertical exaggeration. **c)** Schematic geological section (vertical contacts are arbitrary) based on Pehrsson et al. (2014). *See* legend in Figure 2 for explanation of labels; labels in blue are names attributed to Bostock (2014); gr, granite; SZ, shear zone. S, Sparrow diabase dyke; M, Mackenzie diabase/gabbro dyke. **d)** Magnetic and gravity models. Gravity model (derived in Fig. 6) includes Konth–Slave unit and underlying crustal blocks descending to 22 km depth; contacts are denoted by fine white line superposed on broader navy line. Foliation dips based on Berman and Bostock (1997, their Fig. 3). Modelled magnetic units are colour coded according to the size of the magnetic susceptibility, values of which are plotted.

depths of the flanks of the gravity-modelled Konth–Slave granitic unit and the desire to limit the size of magnetic susceptibilities, susceptibilities of magnetic units within the thin flanks were too low to reproduce the prominent magnetic signatures in domains 1 and 3. This problem was addressed by assigning appropriate susceptibilities to the portions of crust between the bottom of the granitic unit and 6200 m b.s.l. Values of 25 and 71×10^{-3} SI were determined under the west and east flanks of the unit, respectively, above the western block (Fig. 7).

The western portion of the central block above 6200 m b.s.l., apart from a thin surface layer of Berrigan Lake complex, is modelled as several narrow, near-vertical units with susceptibilities ranging from 51 to 123×10^{-3} SI. The eastern portion, underlying a thin wedge of the eastern block, includes two fairly broad units having susceptibilities of 64 and 67×10^{-3} SI. The units are broad, because the short-wavelength components of the cospatial magnetic field are produced by narrow, near-vertical units (susceptibilities: $63–98 \times 10^{-3}$ SI) within the overlying wedge-shaped portion of the eastern block. The mean densities of the central and eastern blocks differ by only 30 kg/m^3 (Fig. 6). Possibly, this change in density, rather than being an abrupt change across a geological contact, is gradational. If so, units modelled within the wedge might extend downward into the central block, and the wedge would not exist as a separate 'structural' feature. The eastern block underlying the broad unit of Nonacho Group includes magnetic units (susceptibilities: $56.5–66 \times 10^{-3}$ SI) extending from surface to 6200 m b.s.l. Across most of the thin western flank of the Konth–Slave unit high susceptibilities ($48–123 \times 10^{-3}$ SI) are modelled, but these values decrease ($11–37 \times 10^{-3}$ SI) within the east end of the flank before dropping to a minimum of 1×10^{-3} SI in the western third of the deeper, central trough-like portion of the unit. Magnetic susceptibilities then increase eastward in the eastern two thirds of the trough ($5–30 \times 10^{-3}$ SI) and finally attain large values ($51–77 \times 10^{-3}$ SI) within the thin eastern flank of the Konth–Slave unit.

The higher magnetic susceptibilities in the eastern part of the main trough may reflect the presence of many metasedimentary xenoliths. A narrow unit of metasedimentary Mama Moose complex is mapped at the eastern end of the Konth–Slave unit, and there is a sizable unit less than 9 km south of the profile line (Fig. 2). This sizable unit trends north and possibly continues northward at shallow depth into the eastern flank of the modelled unit. Bostock (2014) described the complex as a paragneiss comprising migmatite to banded gneiss, commonly upper amphibolite-granulite facies, and containing quartz+K-feldspar+cordierite+sillimanite+biotite+ magnetite assemblages. The higher susceptibilities in this area would be consistent with Culshaw's (1984) observation that the paragneiss contains abundant magnetite.

Profile 3: gravity and magnetic modelling

Profile 3 (Fig. 2, 3, 4) crosses gravity low **A** south of its minimum but where it still has a significant amplitude. The magnetic model is examined first because the maximum development of the gravity anomaly is positioned along the eastern boundary of the Konth granite in magnetic domain 2, and it even extends into the western boundary of domain 3. This scenario influenced the decision to conduct magnetic modelling as the first step.

Magnetic modelling

The overall pattern of magnetic profile 3 (Fig. 8a) is similar to those of other profiles. The portion associated with domain 1 displays two prominent magnetic highs separated by a prominent magnetic low. The western high correlates with the Deskenatlata granodiorite mixed gneiss. The low correlates partly with this mixed gneiss and narrow units of Slave granite and Hill Island Lake metasedimentary rocks and leucogranite associated with minor gneisses (Pehrsson et al., 2014). The eastern high coincides with fairly narrow units of Slave granite and Hill Island Lake assemblage. Suppressed values characterize domain 2 over the central part of the TMZ, correlating variably with units of Konth granite, a fairly narrow unit of Slave granite, and narrow units of the metasedimentary Hill Island Lake assemblage. A distinction of the magnetic field within domain 2 is the presence of two prominent narrow magnetic highs, each attaining amplitudes of roughly 500 nT. One, unexpectedly, is on a unit of Konth granite; the other correlates with a narrow unit of the Mama Moose complex. Domain 3 is characterized by short-wavelength alternating highs and lows correlating variously with the Arch Lake granite and Neoarchean/Paleoproterozoic mixed gneisses.

In domain 2, a Konth–Slave granitic unit is modelled as a basin-like form having a maximum thickness of about 6500 m (Fig. 8d). The approximately 500 nT amplitude magnetic high, centrally situated on Konth granite (Fig. 8a), is modelled as a steeply dipping (65°) unit roughly 1500 m wide and 4 km deep that has a sizable susceptibility of 27×10^{-3} SI. On the magnetic map (Fig. 3) the high is displayed as a discontinuous linear high trending approximately 006° to 025° for about 70 km. Some significantly lower amplitude, narrow, linear anomalies striking northward in the same general area display partial correlation with narrow units of the metasedimentary Hill Island Lake assemblage, but these units are not considered a source for this anomaly. A preferred interpretation, which is based on correlation of a similar magnetic high with a unit of the Mama Moose complex near the eastern edge of domain 2 (Fig. 8a, c), is that the centrally located magnetic high relates to rocks of this complex. A subvertical body of Mama Moose complex similar to that explaining the central high was also derived for the eastern magnetic high. Its susceptibility is much higher (56.5×10^{-3} SI) because it is embedded within a moderately

Figure 8. a) Observed and calculated (model) magnetic profiles and observed Bouguer gravity profile along line of profile 3. A, C, E are gravity anomalies outlined on the Bouguer anomaly map (Fig. 4). Magnetic domains (Fig. 3) are delineated. **b)** Elevation profile; V.E., vertical exaggeration. **c)** Schematic geological section (vertical contacts are arbitrary) based on Pehrsson et al. (2014). *See* legend in Figure 2 for explanation of labels; labels in blue are names attributed to Bostock (2014). S, Sparrow diabase dyke; M, Mackenzie diabase/gabbro dyke. K, Konth granite; gr, granite; SZ, shear zone; L., lake. **d)** Combined gravity and magnetic model; foliation dips are based on Berman and Bostock (1997, their Fig. 3). Modelled magnetic units are colour coded according to the size of the magnetic susceptibility, values of which are plotted. Contacts between modelled gravity units are represented by a fine white line superposed on a heavy navy line; densities of units are in green numbers and in units of kilograms per cubic metre. Base of Konth–Slave magnetic unit is outlined by a heavy red line.

wide unit underlying the eastern half of the modelled Konth–Slave unit that has a sizable susceptibility of 25.5×10^{-3} SI, but whose nature is uncertain.

East of the unit of Mama Moose complex near the eastern boundary of domain 2, narrow vertical units having strong susceptibilities are mapped mainly as granites or Neoarchean/ Paleoproterozoic mixed gneisses at surface. A similar picture is observed for modelled units within domain 1 at the west end of the profile; these units are represented at surface mainly by Slave granite. The interpretation of narrow, steep, high-susceptibility units coinciding with Slave granite, and to a lesser extent Konth granite, does not accord with their classification as ilmenite-series type (Bostock, 2014), which

implies they should be weakly magnetic. A preferred explanation for the coincidence of high-susceptibility units with granites mapped at surface is that the granites contain abundant metasedimentary xenoliths. Alternatively, the granites could be thin and underlain by metasedimentary units.

The most common metasedimentary unit mapped within the TMZ is the Hill Island Lake assemblage (Pehrsson et al., 2014), widely distributed as generally elongate, narrow, northward-trending units that may represent roof pendants. Although the assemblage does not contain rock types with obvious potential to be strongly magnetic (e.g. iron formation), it does contain schists and gneisses (Pehrsson et al., 2014) that may include magnetite-rich layers. Much less

common are enclaves of metasedimentary Mama Moose complex that include paragneisses containing abundant magnetite (Culshaw, 1984).

Gravity modelling

The gravity profile along the line (Fig. 8a) includes a strong gravity low representing anomaly **A** (Fig. 4). Compared to gravity profile 2 (Fig. 6), the axis of the low has migrated eastward from a central position within the unit of Konth granite within domain 2 to a position near the eastern margin of the domain where the low correlates with narrow units of Konth granite, Slave granite, and Mama Moose complex (Fig. 2, 4). The east flank of the low coincides mainly with Arch Lake granite. The spatial relationship of the gravity low to mainly granitic rocks that span the boundary between domains 2 and 3 suggests that a density unit formed of granitic components, and including part of the magnetically modelled Konth–Slave unit, could occupy the crust approximately as far east as the Gagnon shear zone.

Modelling outlines a basin-shaped, low-density unit, potentially composed of Konth and Slave granites, extending between the Deskenatlata granodiorite and the Gagnon shear zone (Fig. 8d). Its base descends to a depth of about 7000 m to form a fairly narrow, deep trough on the eastern margin of domain 2 between shallower flanks. Konth and Slave granites and a unit of Mama Moose complex are mapped at surface above the trough. The western flank is extensive, much of it overlapping the Konth–Slave unit defined by magnetic modelling. In the area of correspondence it is generally from about 1 to 3 km thick, thinning westward. The maximum thickness of the magnetically defined unit is 6.5 km.

If the magnetic and gravity models both have merit, and notwithstanding the offset between the respective anomalies that define them, the lack of closer correspondence between them is puzzling. Given the evidence of a general correlation of the magnetic low defining domain 2 with Konth (mainly) and Slave granites (Fig. 3), the magnetically modelled Konth–Slave unit is likely dominated by granitic rocks that should produce a negative gravity signature. The lack of such a signature along this profile may be related to the significant quantities of metasedimentary xenoliths within the modelled magnetic unit (Fig. 8d) that locally increase the mean density of the hosting granitic unit, thereby suppressing development of any potential gravity low. Another possible example of this kind of density enhancement may be gravity high **D** (Fig. 4), which is displayed prominently in profile 4 (Fig. 9a). Modelling of the magnetic profile along line 4 does not delineate a Konth–Slave granitic unit having the well-defined basin-like shape modelled along other profiles.

Profile 4: magnetic modelling

Magnetic profile 4 (Fig. 9a) resembles profile 3 in having several positive perturbations within domain 2. The largest (~350 nT amplitude) correlates mainly with the Othikethe Falls granite and an adjacent unit of Hill Island Lake assemblage, and another perturbation (~300 nT) falls on the central part of the Konth granite (Fig. 9c). Several closely spaced highs having amplitudes ranging from about 150 to 200 nT are associated with the eastern margin of the Konth granite.

The magnetic model (Fig. 9d) differs from those of all other profiles in terms of the nature and possible configuration of a Konth–Slave granite unit. Rather than deriving a basin-like shape for a weakly magnetic unit, the model shows a series of narrow, steep units, 4000 to 6200 m deep, and some shallower units, roughly 2000 to 3000 m deep. Susceptibilities in all units are generally moderately strong, ranging from 4.5 to 28.5×10^{-3} SI. The apparent more magnetic nature of the Konth granite, and any underlying Slave granite, has precluded the modelling of a weakly magnetic basin-like composite unit as modelled for other profiles. Eastward from the Konth granite, susceptibilities of modelled units increase progressively, attaining more than 30×10^{-3} SI in units of Slave granite, more than 50×10^{-3} SI in the Othikethe Falls granite, and 52.5 to 113×10^{-3} SI in the Arch Lake granite.

The stronger magnetic expression in the eastern part of the Konth granite may be related to 'contamination' of the granite by metasedimentary rocks (this phenomenon was discussed earlier with reference to the Mama Moose complex). In general, the eastern half of the granite in the area north and south of profile 4 contains several scattered, north-trending, narrow units of the Hill Island Lake assemblage that are not extensive: some are aligned in a discontinuous belt. But there are no units mapped on the profile line itself, except the unit separating the western and eastern parts of the Konth granite (Fig. 9c). It is speculated, therefore, that the granite is locally impregnated with many metasedimentary xenoliths, though as previously discussed the source of magnetite in this metasedimentary assemblage is uncertain. This eastern area of the Konth granite coincides with the north-trending gravity high **D** (Fig. 4) that achieves an amplitude of about 9 mGal (Fig. 9a), supporting the presence of abundant xenolithic material in this area.

DISCUSSION

Modelling of magnetic and gravity signatures of the TMZ along four lines, summarized in a quasi-three-dimensional image (Fig. 10), provides insight into the component upper crustal geological units and structures, generally to a depth of about 6.5 km. A probable maximum depth of 14.9 km for a composite Konth–Slave granitic unit
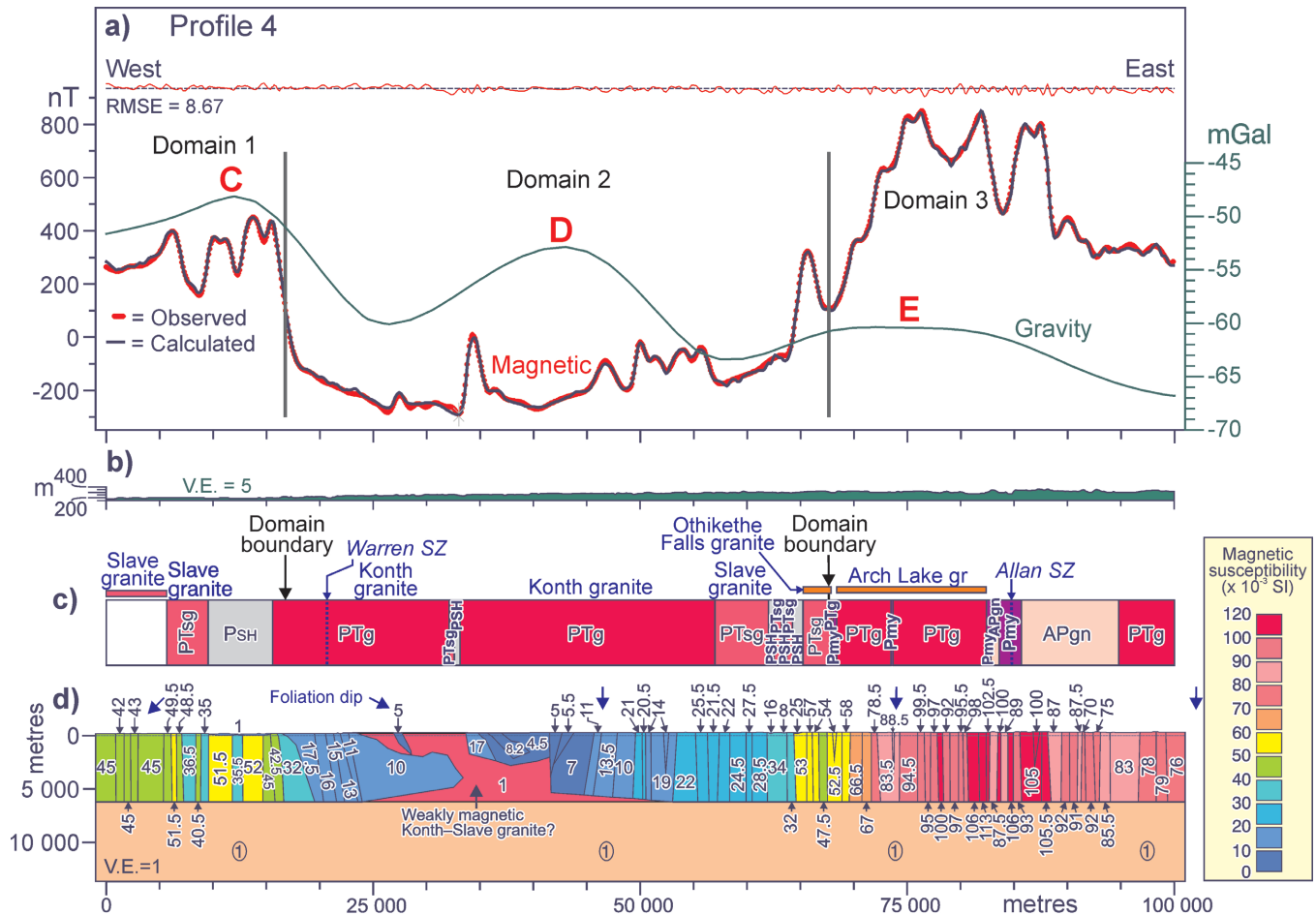
Figure 9. a) Observed and calculated (model) magnetic and gravity profile along line of profile 4. C, D, E are gravity anomalies outlined on the Bouguer gravity anomaly map (Fig. 4). Magnetic domains (Fig. 3) are delineated. **b)** Elevation profile; V.E., vertical exaggeration. **c)** Schematic geological section (vertical contacts are arbitrary) based on Pehrsson et al. (2014). *See* legend in Figure 2 for explanation of labels; labels in blue are names attributed to Bostock (2014); gr, granite; SZ, shear zone. **d)** Magnetic model; foliation dips are based on Berman and Bostock (1997, their Fig. 3). Modelled magnetic units are colour coded according to the size of the magnetic susceptibility, values of which are plotted.

is interpreted on the basis of the prominent gravity low in profile 2, with a maximum depth of 7 km modelled along adjacent profile 3 to the south. Magnetic modelling produces moderately broad basin-like shapes along profiles 1 and 3; these shapes have maximum depths of 5 and 6.5 km, respectively. The gravity model for the Konth–Slave unit for the intervening profile 2 was used to constrain magnetic modelling, an unexpected outcome of which was unusually high magnetic susceptibilities, 12.7 to 30 × 10⁻³ SI, derived for steep units within roughly the eastern third of the deep trough-like part of the unit, and even higher values within its shallow flanks. Konth granite is everywhere mapped at surface, so the high values, apparently, are inconsistent with a uniform attribution as S-type granite by Bostock (2014). Higher susceptibilities are required to reproduce an eastward increase of the magnetic field across the eastern margin of domain 2 and some low-amplitude, short-wavelength positive perturbations that might signify the presence of xenoliths. Evidence from models along all profiles indicates that the

higher susceptibilities are not indicative of a magnetite-series type of granite, but rather of ilmenite-series granites contaminated by metasedimentary xenoliths.

The influence of xenoliths on the magnetic field is perceived in profile 3, where short-wavelength perturbations, one of large amplitude, are present. They are modelled as probable xenolithic bodies within a weakly magnetic, basin-shaped Konth–Slave unit that has a maximum depth of about 6.5 km. An independent gravity model for a Konth–Slave unit also has a broad basin-like shape and a similar maximum depth. However, the two 'basins' overlap laterally, and their centres are mutually offset (Fig. 8d). The gravity model does not extend into the area of the magnetic model, probably because xenoliths in that area raise the general mean density of the upper crust, precluding the development of a gravity low. This argument is supported by the model along profile 4 (Fig. 4), along which gravity high **D** spans central and eastern parts of the Konth granite, in the general
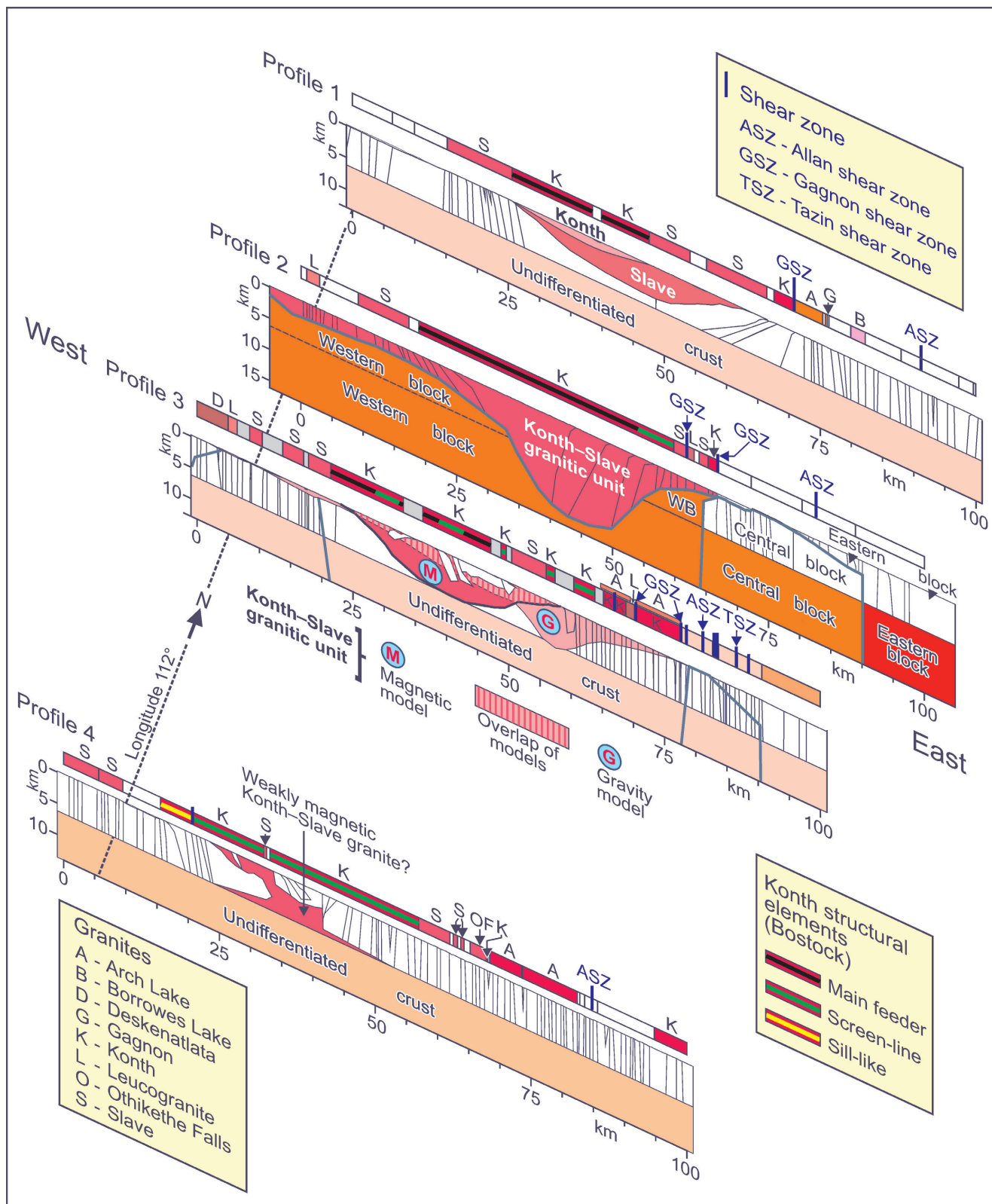
Figure 10. Quasi-three-dimensional composite view of derived models along the lines of profiles 1, 2, 3, and 4. A schematic geological section displaying vertical contacts between geological units accompanies each profile model; only granitoid units are coloured. Portions of Konth granite corresponding to various structural elements defined by Bostock (H.H. Bostock, unpub. rept., 2012) are identified by coloured lines (legend for which is displayed). Nongranitoid modelled magnetic units are generally uncoloured, and only contacts are displayed.

area of which several north-south, narrow belts of metasedimentary Hill Island Lake assemblage are mapped (Fig. 2). Short-wavelength, low-amplitude positive perturbations characterize the broad magnetic low defining domain 2. These are interpreted as reflecting xenolith-rich portions of the Konth granite and are generally modelled as steep magnetic units (Fig. 9d). An irregularly shaped unit extending from surface in the western part of the Konth granite to a depth of about 6.5 km toward its centre has a low susceptibility of 1×10^{-3} SI. This 'window' suggests that even in areas where xenoliths may be abundant, the hosting Konth granite extends to at least a depth of 6.5 km.

The modelled basin-like shapes of a Konth–Slave granitic unit, considered in the context of the wide distribution of metasedimentary screens and potential xenoliths within the Konth and Slave granites, may be relevant to the proposal that sedimentary rocks of Rutledge River Basin were the primary source for the Konth granite (Berman and Bostock, 1997) and for other S-type granites, such as the Slave and Arch Lake granites (McDonough et al., 2000). Berman and Bostock (1997) argued that the Konth–Slave metasedimentary enclaves are refractory vestiges of the pelitic protolith that produced these granites, but they cautioned that significant modal biotite and quartz precluded restite from being a main component of many of their paragneiss samples. Isotopic evidence (Thériault, 1992) indicating the range of ɛNd (−4.7 to −5.5) for peraluminous Konth granite to be within that for metapelitic xenoliths in the Konth and Slave granites (−4.1 to −6.0) was interpreted as implying a genetic relationship between the Konth granite and the xenoliths. It is uncertain whether the Slave granite can be attributed only to 'granitization' of a sedimentary source, because ɛNd values for the Slave suite (−4.4 to −8.6) overlap part of the Nd isotopic evolution path of gneisses of the Buffalo Head terrane and western Rae Province, though potential crustal sources include pelitic xenoliths (Thériault, 1992). Nonetheless, McDonough et al. (2000) suggested that continental collision probably included destruction of Rutledge River Basin and that widespread anatexis of its supracrustal rocks provided a source for S-type magmas, such as the Slave granite. On the basis of these studies it is speculated that the basin-like shapes modelled for the Konth–Slave granitic unit may have been influenced by the configuration of the original Rutledge River Basin.

According to Bostock's subdivision of the Konth granite into four structural segments (H.H. Bostock, unpub. rept., 2012), a section of the granite along profile line 1 falls within the main feeder segment, but this is debatable, given that the modelled Konth granite is thin (Fig. 5, 10). Even though its base is not strictly modelled but is defined by mimicking the shape of the bottom of the composite Konth–Slave unit, the composite unit is fairly thin and not funnel-shaped, which would be more typical of a feeder zone. The main feeder designation is appropriate along profile line 2, where the composite unit attains a thickness of 14.9 km. Profile 3 closely follows the meandering boundary between the main feeder and the screen-line segments, crossing it several times, but a lack of significant magnetic signatures correlating with the boundary precludes modelling. Along profile 4, attribution of the Konth granite as screen-line is supported by the presence of positive gravity anomaly **D** (Fig. 4) and by modelling of many steep magnetic units considered to be xenolith-rich portions of the granite or large xenolithic units.

Magnetic modelling offers a new perspective on the structural fabric of the TMZ and marginal gneissic terrane of the Rae Craton. The fabric as defined is dominated by characteristically narrow magnetic units, typically a few hundred metres to a few kilometres wide, dipping steeply to a depth of several kilometres. Changes in susceptibility across unit boundaries are substantial in many cases, potentially indicating a distinct change in rock type. Within the TMZ, modelled units probably reflect areas of granitoids containing xenoliths, rather than changes in the type of granitoid, whereas units within the Rae Craton more likely reflect different compositions of gneiss. The steepness of the magnetic units within granitoids of the TMZ is supported by the generally steep foliations noted throughout by Berman and Bostock (1997). The Deskenatlata granodiorite is described as largely unfoliated: foliation in most of the central and western parts is weak or absent (H.H. Bostock, unpub. rept., 2012). Nevertheless, steep (generally >60°) to near-vertical foliations are observed at several localities along the eastern margin of the granodiorite, and some are found along the western margin. Foliation in the Slave granite is described as mostly steeply dipping with local shallow to moderately plunging mineral lineation. Dips range from 60° to 75°, eastward or westward, and some are nearly vertical. Foliation dips in the Konth granite generally range from 70° to nearly vertical, either eastward or westward, though in the southwestern part of the unit, north of the Warren shear zone, lower dips of 35° eastward are displayed. These lower dips occur within the screen-like segment of the granite where "foliation dips tend to fan from steep west in the east to shallower east in the west suggesting a slight westward vergence" (H.H. Bostock, unpub. rept., 2012).

The steepness of magnetic units in the dominantly gneissic terrane of the TBC may originate in a manner similar to that proposed for steep structures in gneissic terrane of the TTZ, namely, collisional indentation of the Slave Craton into the Rae Craton (Hanmer et al., 1992), but in this case the Buffalo Head terrane played the role of indenter. A rigid Slave indenter collided with Rae crust having an anisotropy oriented obliquely to the frontal face of the indenter, leading initially to dip-slip displacement along steep planes striking obliquely to the frontal face of the indenter, followed by steepening and rotational hardening of the planes. Subsequently, stress relaxation was brought about by anticlockwise rotation of steep-sided crustal blocks about vertical axes accompanied by strike-slip dextral shear between the blocks. Creation of steep structure in the TBC in this fashion seemingly requires involvement of a rigid indenter in a continental collision. Collisional models involving the

Buffalo Head terrane and Rae Craton have been proposed by Thériault (1992), McDonough et al. (2000), and Card et al. (2014); in their models, the collision was caused by eastward subduction beneath the Rae Craton, though indentation was not specifically discussed.

A few exceptions to modelled steep magnetic units and contacts are observed near the western or eastern margins of modelled Konth–Slave granite units, where dips are moderate and directed inward, possibly signifying coincidental thrusts. Bostock speculated that a gently eastward dipping eastern contact (in places) in the southern part of the Deskenatlata granodiorite, presumably with the Slave granite, had apparently been extensively overthrust by the granite (H.H. Bostock, unpub. rept., 2012), but strong evidence for such thrusting is not apparent in the magnetic models (Fig. 10). However, a series of east-dipping units (contacts dip from 60° to 23°) extending for 11 km across Slave and Konth granites at the boundary between domains 1 and 2 along profile 2 (Fig. 7) could signify west-vergent thrusting. Thrusting in the TMZ south of the study area was discussed by McDonough et al. (2000) with reference to the Charles Lake shear zone (= Allan shear zone), proposed as a fundamental shear zone of a middle-lower crustal transpressive system. This system accommodated southward escape of crust in the upper plate of an oblique continental subduction–collision zone, and shortening was partitioned into synchronous, outwardly vergent thrust systems east and west of the main shear zone. Evidence for such thrusting is not observed in the models derived within the study area.

Several magnetically modelled units dipping at moderate angles near the Gagnon shear zone in the model for profile 1 (Fig. 5) may be associated with thrusting. A boundary between magnetic units intersecting the surface at the Gagnon shear zone dips 74° west, and nearby boundaries dip at progressively shallower angles of 43°, 39°, and 30° westward. The associated units surface mainly in Konth granite and metasedimentary Mama Moose complex. Farther west, the base of the modelled Konth–Slave unit has a shallow westward dip of about 24°. This package of subparallel contacts between the Konth–Slave unit and the Gagnon shear zone may represent a zone of east-vergent thrusting. Apparent restriction of thrusting at the eastern margin of the TMZ to this northern part of the study area may be related to its proximity to the Great Slave Lake shear zone. The influence of forces controlling tectonic development of the shear zone may have extended to the eastern margin of the TMZ.

CONCLUSIONS

Magnetic and gravity modelling provides a new perspective on the possible three-dimensional structural framework of the TMZ and adjacent Rae Craton margin. A configuration of a Konth–Slave granitoid unit has been modelled, and the structural fabric of the TMZ and Rae margin is apparently dominated by narrow, steep units extending to a depth of about 6.5 km. Such units span areas including major shear zones, thereby predicting that the zones are nearly vertical. Only a few gently dipping to moderately steep contacts between units potentially indicating thrusting have been modelled.

Despite shortcomings related to a lack of knowledge of magnetic susceptibilities, the present study provides new perspectives to help guide potential field studies. Future magnetic studies should include establishment of a comprehensive database of rock susceptibilities. Gravity studies could benefit from detailed (close station spacing) surveys along key lines crossing the TMZ and expanding the current database of rock densities.

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