Table A2. Fuzzy analysis for PGE prospectivity

Critical processes	*Appendix figure number*	*Input predictors map*	*Fuzzy-membership value map weight*	*Confidence factor*	*Rationale for expert-knowledge based weight (fuzzy membership values)*	*Rationale for confidence factor*
PGE deposits predominantly occur in large layered intrusions emplaced during the late Archean and early Proterozoic into stabilized, relatively S-poor cratonic lithosphere that provides enhanced preservation potential. The magmas ascend through intracratonic sutures where extension and rifting is limited. Crystallization under conditions of low regional stress, with limited magma-induced sagging due to underlying thick buoyant sub-continental mantle lithosphere, is consistent with their laterally continuous layering (Maier and Groves, 2011).						
Predictor maps for source						
Potential mantle sources for primitive metal-rich magmas include the convecting mantle and the lithospheric mantle. One of the big problems in PGE science is the fixation on unconformity reef style deposits as opposed to contact reefs. The Musgraves is very prospective for contact reefs and indeed for a range of other style of PGE deposits.						
	A1	Distance to mantle-derived, differentiated, Mg rich ultramafic and mafic rocks (Warakurna Supersuite)	9	8	The Warakurna Supersuite is the most probable PGE-potential ressource in terms of age of emplacement (cf. Halleys). Nebo is quite PGE poor, although PGE may occur eg as contact-style mineralization in layered intrusions, or as by-product in Ni–Cu deposits.	Ultramafic and rocks from the Warakurna Supersuite were extracted using spatial query from GSWA (2010b). Ultramafic rocks include peridotite, harzburgite, pyroxenite, gabbronorite, dunite and troctolite. Mafic rocks include basalt, gabbro, troctolite, gabbronorite, dolerite and amphibolite. Chromitite- and orthopyroxenite-hosted reefs tend to be particularly common. 10 km buffer
	A2	Distance to mantle-derived, differentiated, Mg rich ultramafic and mafic rocks (non-Warakurna Supersuite)	8	8	As long as the rocks are derived from the mantle they may be prospective for PGE. But in addition, large layered intrusions, and an intracratonic setting are needed to precipate PGE-deposit, so that sulfides can concentrate; e.g. during late magmatic cumulate unmixing.	Mafic rocks (excluding Warakurna Supersuite) were extracted using spatial query from GSWA (2010b). Mafic rocks include basalt, gabbro, troctolite, gabbronorite, dolerite and amphibolite. Chromitite- and orthopyroxenite-hosted reefs tend to be particularly common. 10 km buffer
	A3	MgO/(MgO+FeO) ratio	7	6	MgO/(MgO+FeO) value of mafic and ultramafic suites is directly related to the amount of olivine crystallized (Bas, 2000). The olivine lattice is the main reservoir of Ni/PGE. Therefore, the higher the MgO content of a mafic-ultramafic suite, the higher its Ni/PGE content and hence its potential to host magmatic sulfides. This value is a true indicator of primitive system and could indicate the earliest pulse (not always). As no primitive magma is required, this factor could be used as an indicator of non-primitive magma, if MgO values are not too high. A melt that is too primitive is not good for PGE endowment.	MgO and FeO data from the GSWA state geochemistry (GSWA, 2010a) and GA Ozchem (GA, 2007) datasets were interpolated and reclassified into classes. CF low because we have interpolated the data in the whole study and some values are not known.
Predictor maps for active pathways						
Magmas need pathways to ascend, which are provided by extension of the crust and lithosphere. All structures may be important, as long as they are trans lithospheric, and intra cratonic. For PGE as by product in Ni Cu systems, many of the same criteria as for Ni Cu systems apply, except that we do not need such primitive magmas. The dynamics of the magma flow and the volume of magma emplaced, commonly in near-vertical feeder conduits, are important in the transport of magma.						
	A4	Distance to crustal-scale fault	9	8.5	These crustal-scale faults were probably active during Giles events. Crustal-scale features are the most important as they drive most of the mineralized fluid (McCuaig et al., 2010; Joly et al., 2010).	Crustal-scale faults were extracted from the interpreted structural geology data and buffered to 10 km. They were identified by 2D gravity and magnetic modeling
	A8	Distance to Mount West Orogeny (MWO) + Musgave Orogeny (MO) structures	8	9	Mafic-ultramafic magmas need a plumbing system to reach upper levels of the crust, which can potentially follow trans-lithospheric faults (Hoatson et al., 2006). Deep-penetrating structures provide pathways for metal transport or create suitable geometries for stress-driven fluid flow, and these fluids migrate or diffuse away from large faults to depositional sites along smaller faults.	Large-scale faults were extracted from the interpreted structural geology data and buffered to 5 km.
	A29	Distance to early Giles 1, mid-Giles (syn-Giles 1), late Giles 3 and post-Giles 1 Event structures	9	9	These structures are linked to the earliest and largest igneous layered intrusions. At this time, there was a change in stress regime. Reverse faulting can trigger fluid migration. The lates Giles 3 and post-Giles structures are coaval with Halleys emplacement and might be the main pathway for metal transport or are likely to create suitable geometries for stress-driven fluid flow. There was a change in stress regime at this time, from dextral transpression to sinistral transpression; this could have induced mineralization flow Q: WHAT IS THIS TERM? – ED	Large-scale faults were extracted from the interpreted structural geology data and buffered to 5 km.
	A30	Distance to early Giles 2, middle (other than syn-Giles 1) and late Giles (other than late Giles 3 and post-Giles 1) Event structures	8.5	9	These structures could be linked to the emplacement of PGE-bearing upper mantle melt component the Giles Complex as they were active at the time of the Giles complex emplacement. However, as they are not strictly operative during the Halleys intrusion, they are considered a bit less prospective.	Large-scale faults were extracted from the interpreted structural geology data and buffered to 5 km.
	A7	Distance to Petermann (PO) + Alice Springs (ASO) structures	8.5	9	Long-lived structures are very good proxies for PGE mineralization. Mafic-ultramafic magmas need a plumbing system to reach upper levels of the crust, which can potentially follow trans-lithospheric faults (Hoatson et al., 2006).	Large-scale faults were extracted from the interpreted structural geology data and buffered to 5 km.

Critical processes	*Appendix figure number*	*Input predictors map*	*Fuzzy-membership value map weight*	*Confidence factor*	*Rationale for expert-knowledge based weight (fuzzy membership values)*	*Rationale for confidence factor*
	A9	Distance to dyke	9	8	Dykes (Glikson et al., 1996) could potentially act as pathways for the PGE sulphides. For the PGEs, it has been shown in different deposits around the world that dykes and chonoliths are very prospective (e.g. Great Dyke in Zimbabwe).	Dykes were queried from interpreted magnetic datasets + GSWA (2010b) dataset; 1 km buffer
	A10	Presence of circular feature	9	6	Vertically stacked magma chambers (or chonolith; (Glikson et al., 1996) could potentially act as pathways for the PGE sulphides. For the PGEs, it has been shown in different deposit around the world that chonoliths are very prospective (e.g. Great Dyke in Zimbabwe).	Mapped using Holden et al. (2010) porphyry detector (from circular in any rocks file porphyry700_1400RTP_CENTRES_t20). Radii values from 700 m to 1400 m were used to determine the size of chonolith to detect. A threshold value of 20 m determines which locations were retained, based on the strength of their radial symetry transform response.
Predictor maps for physical traps						
Reactivation of long-lived sutures may lead to localized extension and, in rare cases, to rifting and cratonic–continental break-up expressed, for example, by the development of flood basalts. More usually, extension is less protracted and rifting is minor and aborted, providing ideal conditions for the emplacement of large, sill-like layered intrusions (Maier and Groves, 2011).						
	A31	Distance to contacts of mafic and ultramafic rocks	9	8	A feature common to sulphide reef-type deposits in layered intrusions is that they tend to occur at, or some distance above, the contact between the lower ultramafic zone and the upper mafic zone. The Bushveld and Stillwater reefs occur some distance above the contact, and the Hartley and Munni Munni reefs (Barnes et al., 1992) lie immediately below this contact. In Shakespeare in Ontario, Canada, the contact-style mineralization is located at the base of the intrusion	Contact of mafic and ultramafic rocks with the basement queried from GSWA datasets; 10 km buffer
	A11	Fault density	6.5	9	Conceptually should have a good correlation with mineralisation. Increased fault density implies greater structural complexity and more space, leading to fluid ponding. Filtering syn-magmatic (EGE) versus post-mafic magmatism faults (MGE, LGE) would have repeated the pathways predictor maps.	All structures mapped well by geology and geophysics
	A12	Distance to fault intersection	6.5	9	Good sites for fluid ponding	All structures mapped well by geology and geophysics
	A13	Fault intersection density	7	9	Indicate greater structural complexity; fluid focusing	All structures mapped well by geology and geophysics
Predictor maps for chemical traps						
Critical elements in the formation of basal segregations of PGE sulfides are the emplacement of S-undersaturated, Ni-bearing tholeiitic magmas into crustal rocks resulting in rapid S-saturation through crustal contamination, mixing of magma of differing compositions, or a rapid fall in temperature (Li & Naldrett 1993, 2000; Naldrett 1997; Lambert et al. 1998, 2000; Ripley et al. 1999). Favourable trap sites for concentration of Ni–Cu–Co sulfides are the feeder conduits and restricted environments, such as structural embayments in the footwall and depressions in the basal contact beneath the thickest succession of cumulates (Hoatson and Blake, 2000). In order to not repeat predictor maps, feeder zones were not input, only the cumulate zone.						
	A14	Distance to mafic and ultramafic rocks	9	8	Mafic and ultramafic rocks are the most common host rock for Ni-Cu mineralization	Mafic and ultramafic units were extracted using spatial query from GSWA (2010b), and interpreted magnetic datasets datasets. 1 km buffer
	A15	Distance to cumulate rocks	9	6	Cumulates are the accumulative component of differentiating magmas. Fractionation of ultramafic magmas can generate cumulates of olivine layers with high MgO and high PGE contents, resulting in the formation of magmatic PGE sulfide, chromium and/or PGE deposits (e.g., Great Dyke, Zimbabwe; Schoenberg et al., 2003). In other words, the presence of cumulate rocks indicates the presence of a trap in which there may also be sulfides.	Identifying cumulates is crucial but challenging in GSWA data. Chromitite, peridotite, and early Giles ultramafic rocks in GSWA database; 10 km buffer
	A32	Distance to dolomite and shale	8	8	Contact-style PGE mineralization formed as a result of the contamination of magmas by the country rocks (Buchanan et al. 1981; Gain and Mostert 1982; White 1994)	Dolomites and shales were extracted from the GSWA datasets; 1000 m buffer
	A33	Granite-gneiss rocks	8	8	Contact-style PGE mineralization formed as a result of the contamination of magmas by the country rocks (Buchanan et al. 1981; Gain and Mostert 1982; White 1994)	Granitic gneisses were extracted from the GSWA datasets; 1000 m buffer

Critical processes	*Appendix figure number*	*Input predictors map*	*Fuzzy-membership value map weight*	*Confidence factor*	*Rationale for expert-knowledge based weight (fuzzy membership values)*	*Rationale for confidence factor*
	A34	Pt content	9	6	PGE deposits are often associated with nickel deposits (e.g., Maier et al., 2007). Residual liquids that are relatively enriched in Cu and Pt may indicate localized fractionation of the sulfide liquid (Maier et al., 2007) and metal extraction at different stages. High values of Pt (Z >4) indicate that the emplaced magma was undersaturated with respect to S. Low values of Pt in ultramafic-mafic suites flows could indicate early S-saturation and metal extraction, and therefore less fertile magmas (Lightfoot, 2007).	Pt values from the GSWA state geochemistry (GSWA, 2010a) and GA Ozchem (GA, 2007) datasets were transformed to standardized Z scores (Singer and Kouda, 2001) and interpolated. The Z scores at which studentized contrast maximized were used as the anomaly thresholds (see Cheng, 2007 for details). Stream and soils are not often analysed for Pt and Pd, although increasingly. So yes, if one has an anomaly, this may be a PGE reef or a Ni Cu deposit with PGE as by-product. CF low because we have interpolated the data in the whole study and some values are not known.
	A35	Pd content	9	6	Indication of fertility of melts and occurrence of nickel extraction processes (Z >2.75)	Pd values from the GSWA state geochemistry (GSWA, 2010a) and GA Ozchem (GA, 2007) datasets were transformed to standardized Z scores (Singer and Kouda, 2001) and interpolated. The Z scores at which studentized contrast maximized were used as the anomaly thresholds (see Cheng, 2007 for details). Stream and soils are not often analysed for Pt and Pd, although increasingly. So yes, if one has an anomaly, this may be a PGE reef or a Ni Cu deposit with PGE as by-product.
	A16	Cr content	9	6	Positive Cr anomalies could be indicative of ultramafic-mafic suites that underwent S-saturation and metal extraction. Cr anomalies are good indicators for PGE, as chromite tends to be concentrated in layered intrusions or ophiolites (where the chromitite pods may also locally be PGE rich). Cr >1000 ppm, Z log Cr >2	Cr values from the GSWA state geochemistry (GSWA, 2010a) and GA Ozchem (GA, 2007) datasets were transformed to standardized Z scores (Singer and Kouda, 2001) and interpolated. The Z scores at which studentized contrast maximized were used as the anomaly thresholds (see Cheng, 2007 for details).
	A36	(Cu/Pd) ratio	9	6	Cu/Pd ratios have proven to be particularly useful for evaluating the PGE potential of intrusions and delineating the position of the reefs within the intrusions, since the strongly chalcophile Pd is preferentially depleted during sulphide segregation, resulting in an increase in Cu/Pd of the subsequently crystallizing overlying cumulates. Z log (Cu/Pd) >2	Cu and Pd values from the GSWA state geochemistry (GSWA, 2010a) and GA Ozchem (GA, 2007) datasets were transformed to standardized Z scores (Singer and Kouda, 2001) and interpolated. The Z scores at which studentized contrast maximized were used as the anomaly thresholds (see Cheng, 2007 for details). CF low because we have interpolated the data in the whole study and some values are not known.
	A26	Ni content	6.5	6	Negative Ni anomalies associated with ultramafic-mafic suites could be indicative of early S-saturation and metal extraction, whereas positive Ni anomalies could point to PGE accumulation. These are not so important for PGE, as they tend to be incompatible during magmatic differentiation and thus may still be high even in some more differenticated magmas, as long as no external sulfur was added. (Ni >300 ppm).	Ni values from the GSWA state geochemistry (GSWA, 2010a) and GA Ozchem (GA, 2007) datasets were transformed to standardized Z scores (Singer and Kouda, 2001) and interpolated. The Z scores at which studentized contrast maximized were used as the anomaly thresholds (see Cheng, 2007 for details). CF low because we have interpolated the data in the whole study and some values are not known.
	A27	Cu content	6.5	6	Positive Cu anomalies (>90 ppm) could be indicative of ultramafic-mafic suites that underwent S-saturation and metal extraction and, therefore, potentially fertile magmas. Some examples of the world's large intrusive nickel–copper sulfide deposits are Noril'sk, Pechenga, Voisey's Bay, Jinchuan, and Kabanga (Maier et al., 2007). High PGE are commonly associated with high Cu, but many Cu deposits do not contain PGE, and are not magmatic.	Cu values from the GSWA state geochemistry (GSWA, 2010a) and GA Ozchem (GA, 2007) datasets were transformed to standardized Z scores (Singer and Kouda, 2001) and interpolated. The Z scores at which studentized contrast maximized were used as the anomaly thresholds (see Cheng, 2007 for details). CF low because we have interpolated the data in the whole study and some values are not known.
Undefinable predictor maps						
		Komatiite	8	8	Komatiites are globally the most prospective host rocks for magmatic nickel sulfide deposits (e.g. In the Yilgarn Craton; Abitibi, Canada, where nickel sulfide deposits are almost exclusively associated with komatiites (Hoatson et al., 2006; Maier and Groves 2011)).	No komattite in this non-Archean area; this is not relevant for the Musgrave area

Critical processes	*Appendix figure number*	*Input predictors map*	*Fuzzy-membership value map weight*	*Confidence factor*	*Rationale for expert-knowledge based weight (fuzzy membership values)*	*Rationale for confidence factor*
		Mg/(Mg+Fe) ratio	6	7.5	Mg/(Mg+Fe) value of mafic and ultramafic suites is directly related to the amount of olivine crystallized (Le Bas, 2000). The olivine lattice is the main reservoir of Ni. Therefore the higher the MgO abundance of a mafic-ultramafic suite, the higher its Ni content and hence its potential as the source rock for magmatic nickel sulfide deposits. This value is a true indicator of primitive system and could indicate the earliest pulse.	In the case of PGE, primitive magmas and rocks are not so necessary. Many reefs occur in quite differentiated cumulates, so this factor is perhaps not so relevant (Maier, personnal communication).
		Craton	7	6	All significant PGE deposits are associated with stabilized cratons and most occur within the central segments of the cratons.	Scale problem: the 3 cratons were accreted during the Giles Event (Rodinia). This predictor map should have been in pathway critical process. The craton margins are the pathways; the new seismic data display the possible suture zone.
		Crustal contamination (indicated by anomalous Th/Yb, Th/Nb, and La/Nb values)	8	7.5	S-saturation may be triggered by addition of external S due to devolatization, partial melting, or bulk assimilation of S-rich upper continental crustal rocks (Lesher and Campbell, 1993). Upper continental crustal rocks are enriched in incompatible elements. Anomalous values of the ratios of incompatible elements such as Th/Yb, Th/Nb, and La/Nb within the ultramafic-mafic suites can be applied as indicators of crustal contamination, and therefore S-saturation (e.g. Naldrett, 1997).	PGE deposits do not require contamination, and this may even be a negative factor.
		Sulfur unit	7	7.5	We don't want external S in PGE deposits.	Presence of S-rich country rocks is a negative PGE factor.
		Fe-rich rocks (magnetite presence in P_-WKg1-am unit)	7	8	Indication of potential S sources, but external crustal S addition did not play a role in the Nebo–Babel ore genesis (Seat et al., 2009).	Not Important for PGE
		S content	8	7.5	Contamination of ascending magma with S-enriched country rocks may lead to S-saturation of the magma, and formation and segregation of immiscible nickel sulfide liquid (Naldrett, 1997; Prendergast, 2004]), thereby resulting in precipitation of nickel sulfides.	It is a negative factor
		Al_2O_3/TiO_2	7	7.5	Fertile komatiitic provinces are dominated by Al-undepleted komatiites (AUDK) or ‘Munro-type’ komatiites with Al_2O_3/TiO_2 values between 15 and 25 (e.g., Eastern Goldfields, Australia; Thomson belt, Canada; Zimbabwe Craton, Zimbabwe; Hoatson et al., 2006). However, Al-depleted komatiites (ADK; Al_2O_3/TiO_2 <15) or ‘Barberton-types’ also host significant deposits (e.g., Pibara Craton, Australia; Crixás Belt, Brazil; Barberton Belt, South Africa; Hoatson et al., 2006).	No komattite in this non-Archean area; this is not relevant for the Musgrave area.
		(Ni/Cr) x (Cu/Zn) ratio	8	7.5	This factor is used in WA as a vector towards Komatiite Ni mineralization (Brand, 2004).	No komattite in this non-Archean area; this is not relevant for the Musgrave area.
		Presence of chalcopyrite, pyrrhotite, pentlandite+ PGE minerals	8	6	However, the main sulfide minerals are similar, consisting of pyrrhotite, pentlandite (which may be dominant in komatiitic ores) and chalcopyrite (which may be dominant in gabbronoritic ores and in ores that crystallized from fractionated sulfide liquids).	Chalcopyrite, pyrrhotite, pentlandite and PGE minerals were extracted using spatial query from GSWA (2010) mineral occurrence database. None found in the database