The data mining and knowledge discovery from databases paradigm in environmental research: How far can it get you?

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Data mining is used to uncover patterns and relationships in very large financial, census, remote sensing, medical imaging databases …and to rapidly extract useful knowledge from them. The term "data mining" has arisen from the artificial intelligence, machine learning, and pattern recognition literature; it is often referred to as "data mining and knowledge discovery in databases" or DM &KDD.

A DM&KDD paradigm has been used to construct Australia-wide soil property predictions from a national soils database. The database includes over 160,000 soil profile descriptions and associated laboratory analyses (point database); a compilation of soil and land resources maps and other relevant datasets (lithology, digital elevation model and derived terrain attributes, climate surfaces, Landsat MSS imagery). The point data have been collected by many people, at multiple locations and times, and are sometimes incomplete. The soil properties predicted spatially include pH, organic carbon, total phosphorus, total nitrogen, thickness, texture and clay content. Models are constructed at the 250 m resolution using decision trees. These relate the soil property to the environment through a suite of 250 m resolution environmental predictors at the locations where measurements are observed. These models are then used to extend predictions to the continental extent by applying the rules derived to the exhaustively available environmental predictors. The methodology and performance will be described in detail for pH and summarized for other properties. Environmental variables are found to be important predictors, even at the 250 m resolution at which they are available here as they can describe the broad changes in soil property.

The behaviour of the titanite U-Pb system during polymetamorphism: Evidence from the Harts Range Complex, Arunta Inlier, central Australia

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Metabasites from the Harts Range Complex were metamorphosed to granulite grade (~8-10 kbar; ~800-850 ˚C) at ~470 Ma (SHRIMP U/Pb zircon; Grt Sm/Nd) and subsequently variably reworked during the amphibolite-grade ~440-300 Ma Alice Springs Orogeny (ASO). Metabasites contain porphyroclasts of Hbd+Grt+Cpx+Ilm +Tit within a matrix of high-temperature recrystallised Pl+Qtz. Dense systems of healed fluid inclusion trails and Act Hbd±Chl fractures cut the garnet at a high angle to the granulite-grade fabric. High-temperature microstructures are locally re-worked by shear bands containing Ep-Act Hbd±Chl that formed during the ASO.

Titanite from two metabasites dated as grain mounts both gave pooled SHRIMP ^{238}U-^{206}Pb ages of ~420 Ma. Additionally, one yielded a second pooled ^{238}U-^{206}Pb age of ~385 Ma. Neither contained a ~470 Ma Tit population even though titanite was commonly included within refractory garnet. SHRIMP U-Pb Tit dating in thin section from the metabasite having the two age populations shows the following: 1) individual Tit U-Pb spot ages vary from ~480 to ~320 Ma; 2) the oldest spot ages (~480-460 Ma) are only rarely preserved, even in inclusions in the cores of 1-2 cm diameter garnets; 3) Tit inclusions from positions intermediate between the cores and rims of fractured garnet yield apparent U-Pb ages of ~435-415 Ma; younger ages (~410-390 Ma) occur in more highly fractured garnet rims; 4) oriented elongate Tit grains in the external mylonitic matrix generally yield ages of ~380-390 Ma; 5) some Tit grains are composite, containing irregular domains that yield c. 430 and ~390 Ma ages; 6) ~360-340 Ma ages come from narrow Tit rims on Ilm cores within narrow, ASO shear bands; 7) dense networks of Tit-filled fractures cutting ~350 Ma Tit yield the youngest age, ~320 Ma.

The range of apparent *in situ* titanite U-Pb ages reflects its initial occurrence as part of the peak-metamorphic ~470 Ma granulite assemblage; several episodes of partial resetting of the Tit U-Pb system, which may have been facilitated by fluid-assisted mass transfer along dense fracture networks in the garnet prophyroclasts during polyphase shearing; and new ASO-related growth. Signficantly, during ASO deformation garnet provided little protection for included titanite from resetting of its U-Pb system.