RADIOMETRIC MAP OF AUSTRALIA

Australian Government
Geoscience Australia

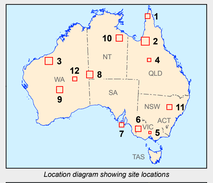
SCALE 1:5 000 000

0 100 200 300 400 500 Kilometres

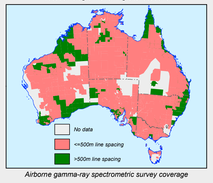
LAMBERT CONFORMAL CONIC PROJECTION
Central Meridian: 134°E Standard Parallels: 18°S, 36°S
Geocentric Datum of Australia

INDONESIA
PAPUA NEW GUINEA
TIMOR SEA
TORRES STRAIT
Joseph Bonaparte Gulf
Gulf of Carpentaria
CORAL SEA
Great Barrier Reef
1000m
200m
INDIAN OCEAN
Great Australian Bight
SOUTHERN OCEAN
TASMAN SEA
BASS STRAIT

Radiometric Signatures of Bedrock and Regolith Materials



Location diagram showing site locations



Airborne gamma-ray spectrometric survey coverage

Site 1. Weipa bauxites. *High eTh response (green) associated with pisolitic and nodular bauxite. Elevated eTh reflects accumulation of resistate minerals (e.g. zircon, monazite) and retention of Th in the weathering profile by clays and Fe-oxyhydroxides.*

Site 2. Alluvial fans. *Large, low angle alluvial fans (some of the largest in the world) consisting mainly of sand, clay, gravel and minor silt. Active fan deposition commonly delineated in whitish hues and less active fan sediments in darker hues. Responses also vary according to the provenance of the sediment.*

Site 3. Pilbara Region. *Well exposed Archaean and lower Proterozoic rocks of the Pilbara region consisting of granites (whitish hues – high in all three radio- elements) forming circular to sub-circular plutons surrounded by ultramafic rocks (dark hues – low in all three radioelements).*

Site 4. Residual plains. *Extensive low relief, undulating erosional plains consisting of residual clay and rocky lags over highly weathered Cretaceous bedrock (Rolling Downs Group).*

Site 5. Baynton Granodiorite. *Late Devonian granite pluton (reddish hues) surrounded by Miocene basalts (green hues) and metasedimentary bedrock (whitish hues).*

Site 6. The Little Desert. *Mobile aeolian dune sheets (black hues) consisting of yellow-grey to pale orange well sorted quartz sand. The sands have been reworked from coastal sand dunes to the southwest.*

Site 7. Kangaroo Island. *Ferruginous duricrust and gravels overlying very highly weathered Cambrian sediments. High eTh associated with clays, resistate minerals and Fe-oxyhydroxides in the upper part of the weathering profile.*

Site 8. Petermann Range. *Slightly weathered granite (white hues) shedding sediment in the form of sheet flow colluvial fans. Colluvial sediments have been reworked into aeolian sand plains. The sands have a high K-feldspar and K-mica content which is reflected in the high K response (reddish hues).*

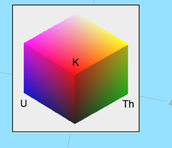
Site 9. Eastern Goldfields. *Complex mosaic of bedrock and regolith patterns. Exposed granite appears mainly in white hues with sheetflow colluvial deposits derived from the granite bedrock in reddish hues reflecting K-feldspar and/or mica sand grains. Mafic rocks and quartz rich aeolian sands typically have low gamma-ray emissions. Ferruginous lags and silcrete are delineated by high eTh content (green hues). Valley sediments and calcrete are delineated by mixtures of eU and K (purple hues).*

Site 10. Edge of the Barkley Tablelands. *The radiometric image shows a distinct boundary between the highly ferruginous and weathered Jurassic sediments delineated by high eTh (green) responses from slightly weathered Proterozoic sandstones and dolomites in reddish hues.*

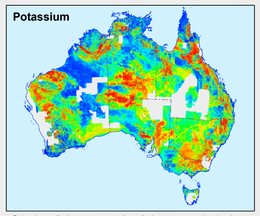
Site 11. Warrumbungle Volcano. *The central core of the volcano is being actively eroded and consists of exposed basalt, dolerite and trachyte (white to reddish hues). Colluvial fan sediments to the west of the volcano have a similar signature to the bedrock. To the east, highly weathered flat-lying Jurassic sediments are denoted by their high eTh content (green hues).*

Site 12. Lake Breaden. *The lake has formed within a palaeodrainage system (now largely inactive) consisting of alluvial sand, silt, clay and minor gravel (dark hues). Extensive low relief plains consisting of ferruginous colluvial sheetflow sediments and residual sands and gravels are delineated by their high eTh content (green hues).*

NOTE: *As uranium and thorium abundances are measured indirectly from daughter nuclides in their respective decay chains uranium and thorium concentrations are expressed in units of "equivalent" parts per million (eU and eTh).*

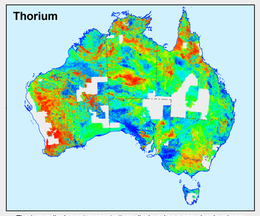


Potassium



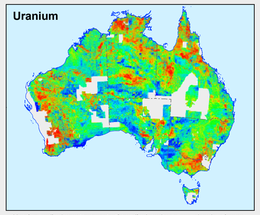
Potassium radioelement concentrations displayed as a pseudocolour image (red high, blue low).

Thorium



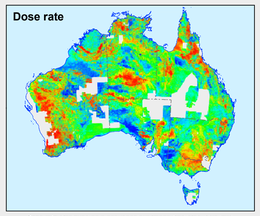
Thorium radioelement concentrations displayed as a pseudocolour image (red high, blue low).

Uranium



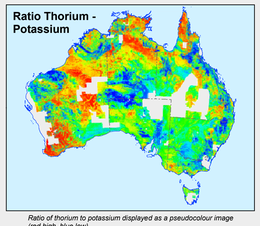
Uranium radioelement concentrations displayed as a pseudocolour image (red high, blue low).

Dose rate



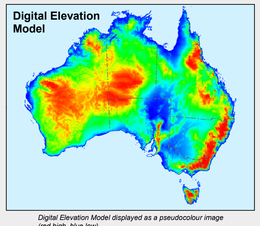
Dose rate displayed as a pseudocolour image (red high, blue low).

Ratio Thorium - Potassium



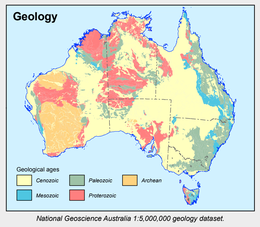
Ratio of thorium to potassium displayed as a pseudocolour image (red high, blue low).

Digital Elevation Model



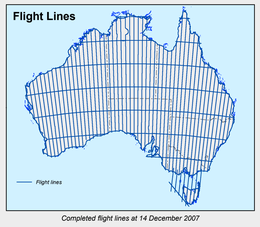
Digital Elevation Model displayed as a pseudocolour image (red high, blue low).

Geology



National Geoscience Australia 1:5,000,000 geology dataset.

Flight Lines



Completed flight lines at 14 December 2007

EXPLANATORY NOTES:
The ternary radiometric image shows the concentrations of the radioelements potassium (K), uranium (U) and thorium (Th) at the Earth's surface as measured using the airborne gamma-ray spectrometric method. The image is a false colour composite using the colours red, blue and green to represent potassium, uranium and thorium, respectively. These primary colours are mixed in the same proportions at each point on the map as the concentrations of the radioelements. Thus white areas have high concentrations of all the radioelements and dark areas have low concentrations. Areas high in K only appear red, and areas high in U and Th but low in K appear turquoise (a mixture of green and blue). So this representation of the data is useful for viewing the concentrations of all three radioelements in a single image.

The distribution of the radioelements reflects the geochemistry and mineralogy of bedrock and regolith materials. K, U and Th precipitate late in the igneous and volcanic crystallisation sequence. Thus felsic igneous and volcanic equivalents are usually high in these elements and mafic rocks low. A general increase in K, U and Th with increasing bedrock silica content is usually observed. Surface weathering modifies the distribution of these elements, and their concentration in weathered material can differ significantly from fresh bedrock. K is often leached from highly weathered bedrock, whereas U and Th are retained by association with resistate minerals, clay and oxides in the weathering profile.

The airborne gamma-ray spectrometric data used to compile this map were acquired by Geoscience Australia and State and Territory Geological Surveys over a period of about 40 years. During this period there were significant changes in the technology and techniques used to estimate the radioelement concentrations. As a result, the radiometric survey data were not all registered to the same baseline. To solve this problem, Geoscience Australia commissioned UTS Geophysics Pty Ltd to conduct an Australia-wide Airborne Geophysical Survey (AWAGS) to be used to establish a consistent radioelement baseline for Australia.

The survey was funded under the Australian Government's Onshore Energy Security Program with the flying phase of the survey completed in December 2007 and the final processed radiometric data delivered in June 2008. The survey covers the entire continent with north-south flight lines spaced 75 km apart, and east-west tie lines spaced 400 km apart. Gamma-ray spectrometric data, acquired at a nominal 80 metre terrain clearance along the flight lines, was processed to be consistent with an international baseline established by the International Atomic Energy Agency. The final estimates of the radioelement concentrations along the survey lines comprise the new Australian radioelement baseline.

The radiometric data contained in the National Airborne Geophysical Database have been levelled to the new baseline by minimising both the differences in radioelement concentration estimates between surveys (where these surveys overlap) and the differences between the surveys and the AWAGS traverses (where these overlap) using an enhancement of the method described by Minty (2000).

This edition of the Radiometric Map of Australia has been produced from 558 individual survey grids that have been matched and merged into composite K, U and Th grids over Australia at 100 metre resolution. The data are from surveys flown by Geoscience Australia, and surveys flown under contract to Geoscience Australia and the State and Territory Geological Surveys. The source data are used with their permission. The surveys were flown with a range of line spacings (see source diagram), flying heights, and measurement accuracies (Percival, 2008).

Data was supplied by: Geoscience Australia; New South Wales Department of Primary Industries; Department of Primary Industries Victoria; Department of Mines and Energy Queensland; Department of Primary Industries and Resources South Australia; Department of Industry and Resources Western Australia; Department of Infrastructure, Energy and Resources Tasmania; and the Department of Regional Development, Primary Industry, Fisheries and Resources Northern Territory. Most of the data were acquired at an altitude of 100 metre or less along lines spaced 500 metre apart or less.

For each of K, U and Th, individual surveys were gridded using a cell size of approximately one-fifth of the survey line spacing, with some grids subjected to micro-levelling (Minty, 1991). The grids were levelled to the AWAGS baseline, as described earlier, and then low-pass filtered using a 7-point, degree-3 Savitzky-Golay filter (Savitzky and Golay, 1964). K, U and Th merged grids were created by interpolating each survey grid onto a regular grid with a cell size of 3.75 seconds of arc using the minimum curvature method of Briggs (1974), and the grid boundaries seamlessly feathered (Minty, 2000). The final grids were then reprojected to the Lambert Conformal Conic projection with a cell size of 100 metre. For imaging purposes, concentrations were normalised to a 0-255 range through histogram equalisation.

REFERENCES:
Briggs, I.C., 1974, *Machine contouring using minimum curvature*: Geophysics, **39**, 39-48.
Minty, B.R.S., 1991, *Simple micro-levelling for aeromagnetic data*: Exploration Geophysics, **22**, 591-592.
Minty, B.R.S., 2000, *Automatic merging of gridded airborne gamma-ray spectrometric surveys*: Exploration Geophysics, **31**, 47-51.
Percival, P.J., 2008, *Index of Geophysical Surveys, (Tenth Edition)*: Geoscience Australia Record 2008/01.
Savitzky, A., and Golay, J.E., 1964, *Smoothing and differentiation of data by simplified least squares procedures*: Analytical Chemistry, **36**, 1627-1639.

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Cartography: S. Mezzomo, Geospatial Applications and Visualisation, Geoscience Australia.

It is recommended that this map be referred to as: Minty, B.R.S., Franklin, R., Milligan, P.R., Richardson, L.M. and Wilford, J., 2008., Radiometric Map of Australian (First Edition), scale 1:5 000 000, Geoscience Australia, Canberra.

The composite K, U and Th radiometric grid data at 100 metre cell sizes are available for free download via the internet using Geoscience Australia's Geophysical Archive Data Delivery System (GADDS) at: http://www.geoscience.gov.au/gadds

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Sales Centre
Geoscience Australia
GPO Box 378
Canberra, ACT 2601
Phone (02) 6249 9966
Facsimile (02) 6249 9960
Email: sales@ga.gov.au

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