



Curtin University

THE INSTITUTE FOR  
GEOSCIENCE RESEARCH (TIGeR)

# 2016 TIGeR CONFERENCE

Rock alteration in the upper crust:  
Element mobility and concentration

26-28 September, 2016  
Curtin University, Perth  
PROGRAM

Make tomorrow better.

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The aim of this 3-day conference is to promote progress at the leading edge of this topic through presentations and open-forum discussion.

We will focus on key aspects of:

- rock hydration and carbonation: length and time scales
- element mobility and enrichment
- mineralisation
- enhanced alteration: in situ recovery
- environmental remediation
- reactions and transport in the critical zone
- geomicrobiology/biogeochemistry

The total number of participants will be limited to about 80-100 to facilitate active participation and open discussion, so register early to avoid disappointment.

## THE AGENDA

The aim is to have short presentations (20 minutes for keynote speakers, 10 minutes for other talks) focusing on specific issues for later discussion. Afternoon poster sessions will provide further discussion time. The detailed schedule will be sent out after the registration period.

## SPEAKERS INCLUDE:

Steve Barnes (CSIRO, Perth)  
Lukas Baumgartner (U.Lausanne)  
Liane Benning (GFZ, Potsdam)  
Charles Butt (CSIRO, Perth)  
Bill Collins (Curtin U., Perth)  
Kathy Ehrig (BHPBilliton)  
Marco Fiorentini (UWA, Perth)  
Kliti Grice (WA -OIG, Curtin, Perth)  
Ben Grguric (South Australian Museum)  
Dan Harlov (GFZ, Potsdam)  
Anna Harrison (U. Toulouse)  
Laura Kuhar (CSIRO)  
John Mavrogenes (ANU, Canberra)  
Tadao Nishiyama (Kumamoto U., Japan)  
Hugh O'Neill (ANU, Canberra)  
Ian Power (UBC, Vancouver)  
Allan Pring (Flinders U., Adelaide)  
Frank Reith (U. Adelaide)  
Dave Robinson (CSIRO)  
Carl Spandler (James Cook U., Townsville)  
Gordon Southam (U. Queensland)  
Lijun Wang (Huazhong Agricultural U., Wuhan, China)  
Sasha Wilson (Monash U., Melbourne)  
Jan Wijbrans (U. Amsterdam/U. Leiden)  
Bruce Yardley (Leeds U.)

# ORAL PRESENTATIONS

## MONDAY 26 SEPTEMBER

### 9AM TO 10.45AM WELCOME, REGISTRATION AND TEA/COFFEE ICEBREAKER

Andrew Putnis, Director, The Institute for Geoscience Research (TIGeR)

### 9.45AM TO 10.05AM + 10 MINUTES DISCUSSION

Ian Power

Low temperature magnesite formation: Implications for carbon sequestration

### 10.15AM TO 10.25AM + 5 MINUTES DISCUSSION

Bree Morgan

Magnesite forms from CO<sub>2</sub> released during decomposition of hydrated Mg-carbonate phases

### 10.30AM TO 10.50AM + 10 MINUTES DISCUSSION

Sasha Wilson

Dissolution-precipitation reactions control the stability of CO<sub>2</sub> and transition metal trapping in hydrated Mg-carbonate minerals

### 11AM TO 11.20AM + 10 MINUTES DISCUSSION

Lukas Baumgartner

A SIMS study of oxygen isotope exchange around veins in dolomite xenoliths in shallow intrusions

### 11.30AM TO 11.40AM + 5 MINUTES DISCUSSION

Weihua Liu

Speciation and thermodynamics of HCl in hydrothermal fluids up to 700 °C and 60 kbar by molecular simulations

### 11.45AM TO 11.55AM + 5 MINUTES DISCUSSION

Tom Raimondo

Tracing geochemical mobility, alteration and mineralisation with LA-ICP-MS mapping

### 12PM TO 1PM LUNCH

### 1PM TO 2PM POSTER SESSION

### 2PM TO 2.20PM + 10 MINUTES DISCUSSION

Grant Douglas

Hydrotalcite formation for trace element and radionuclide removal from uranium mine barren lixiviant: Beverley ISR Uranium Mine

### 2.30PM TO 2.50PM + 10 MINUTES DISCUSSION

Laura Kuhar

Copper deposit solution chemistry and its importance in in-situ recovery applications

### 3PM TO 3.10PM + 5 MINUTES DISCUSSION

Jacques Eksteen

Minerals, metals and amino acid interactions in the hydrometallurgical extraction of chalcophile and precious metals from their ores

### 3.15PM TO 3.45PM COFFEE/TEA BREAK

### 3.45PM TO 3.55PM + 5 MINUTES DISCUSSION

Katy Evans

The geodynamic setting of serpentinitisation: Does it matter?

### 4PM TO 4.20PM + 10 MINUTES DISCUSSION

Hugh O'Neill

Problems caused by multiple substitution mechanisms of trace elements in crystals

### 4.30PM TO 4.50PM + 10 MINUTES DISCUSSION

Yuanfeng Cai

The effect from solubility on mechanism study of "mineral-hydrothermal solution" Two case studies

### 5PM TO 6PM POSTER SESSION

### 6PM TO THE BBQ OUTSIDE BUILDING 312

## SPONSORS



## TUESDAY 27 SEPTEMBER

### 9AM TO 9.20AM + 10 MINUTES DISCUSSION

Marco Fiorentini

Metal and Sulfur cycle in the deep continental crust: Insights from the Ni-Cu-PGE sulfide deposits of the Ivrea Zone (Italy)

### 9.30AM TO 9.40AM + 5 MINUTES DISCUSSION

Crystal LaFlamme

Anomalous sulfur isotope signatures preserved in the Proterozoic Capricorn Orogen: Linking fluid-driving tectonic processes and ore genesis at craton margins

### 9.45AM TO 10.05 AM + 10 MINUTES DISCUSSION

Steve Barnes

Mobility (or otherwise) of Ni, PGEs and Au during hydration and carbonation of sulfide-bearing komatiites

### 10.15AM TO 10.45AM COFFEE/TEA BREAK

### 10.15AM TO 11.05AM + 10 MINUTES DISCUSSION

John Mavrogenes

High temperatures recorded in quartz-anhydrite-sulfide veins from the giant Grasberg porphyry, Papua.

### 11.15AM TO 11.35AM + 10 MINUTES DISCUSSION

Allan Pring

The creation and healing of porosity in coupled dissolution-reprecipitation replacement reactions

### 11.45AM TO 12.05PM + 10 MINUTES DISCUSSION

Ben Grguric

Things go faster with water: New experimental findings on exsolution microstructures in hydrothermally synthesised Cu-Fe sulphides

### 12.15PM TO 1.15PM LUNCH

### 1.15PM TO 2.15PM POSTER SESSION

### 2.15PM TO 2.25PM + 5 MINUTES DISCUSSION

Paul Duuring

Geochemical and spectral vectors for metamorphosed and deformed VMS-style mineralisation in the Quinns district, Yilgarn Craton, Western Australia

### 2.30PM TO 2.50PM + 10 MINUTES DISCUSSION

Kathy Ehrig

The Olympic Dam mineral system

### 3PM TO 3.20 PM + 10 MINUTES DISCUSSION

Carl Spandler

Titanite as a monitor of hydrothermal and magmatic processes

### 3.30PM TO 4PM COFFEE/TEA BREAK

### 4PM TO 4.10PM + 5 MINUTES DISCUSSION

Mark Pearce

Microstructural evidence for copper remobilisation in IOCG deposits

### 4.15PM TO 4.35PM + 10 MINUTES DISCUSSION

Tadao Nishiyama

Hydrothermal chloritisation processes of biotite in the Toki granite, Central Japan: Singular value decomposition analysis of reaction relations and the temporal variations in fluid compositions

### 4.45PM TO 4.55PM + 5 MINUTES DISCUSSION

Alistair White

Distinguishing local-scale and regional-scale metasomatic systems

### 5PM TO 5.10PM + 5 MINUTES DISCUSSION

Kliti Grice

Lord Howe Rise deep stratigraphic drilling: Tectonics, climate and ancient life

### 5.15PM TO 6PM POSTER SESSION

### 6PM BUS TO THE BOATSHED RESTAURANT FOR THOSE SIGNED UP FOR THE CONFERENCE DINNER

## WEDNESDAY 28 SEPTEMBER

### 9AM TO 9.20AM + 10 MINUTES DISCUSSION

Ravi Anand

Weathering, regolith-landscape evolution and element mobility

### 9.30 - 9.40 + 5 MINUTES DISCUSSION

Christine Putnis

Control of silicate weathering processes at the mineral-fluid interface

### 9.45AM TO 9.55AM + 5 MINUTES DISCUSSION

Andrew Rate

Continental-scale correlation of regolith trace elements with iron

### 10AM TO 10.10AM + 5 MINUTES DISCUSSION

Andrew Friedrich

Catalysing mineral recrystallisation at low temperature: A new pathway to unlock metals from laterites?

### 10.15AM TO 10.45AM COFFEE/TEA BREAK

### 10.45AM TO 10.55AM + 5 MINUTES DISCUSSION

Nian Xu

Rare earth element behaviour and iron sulfide formation in dredge spoils and adjacent sediments

### 11AM TO 11.10AM + 5 MINUTES DISCUSSION

Elizabeth Watkin

Incorporation of indigenous microorganisms increases rare earth leaching rates from Western Australian monazite.

### 11.15AM TO 11.35AM + 10 MINUTES DISCUSSION

Frank Reith

Geobiology in exploration: Using bioindicators and biosensor in Australia

### 11.45AM TO 12.05PM + 10 MINUTES DISCUSSION

Gordon Southam

Bacteria-mineral interactions

### 12.15PM TO 12.25PM + 5 MINUTES DISCUSSION

Talitha Santini

Connecting geochemistry and microbiology in ancient, saline environments at extremes of pH: Insights from Western Australian salt lakes

### 12.30PM TO 1.20PM LUNCH

### 1.30PM TO 2PM POSTER SESSION

### 2PM TO 2.20PM + 10 MINUTES DISCUSSION

Anna Harrison

The impact of evolving mineral-water-gas interfacial areas on mineral-fluid reaction rates in unsaturated porous media

### 2.30PM TO 2.50PM + 10 MINUTES DISCUSSIONS

Lijun Wang

Biogeochemical cycle of silicon and biosilification

### 3PM TO 3.20PM + 10 MINUTES DISCUSSION

Kliti Grice

Preservation and evolution of life across ocean anoxic events

### 3.30PM TO 4PM COFFEE/TEA BREAK

### 4PM TO 4.20PM + 10 MINUTES DISCUSSION

Jan Wijbrans

Tracing fluid channeling in the continental crust

### 4.30PM TO 4.50PM + 10 MINUTES DISCUSSION

Dan Harlov

Ilmenite breakdown and rutile-titanite stability in metagranitoids: Natural observations and experimental results

### 5PM CLOSE



# POSTERS

## CONSTRAINTS ON REACTION FRONT PROPAGATION RATES IN SERPENTINITE FROM LI ISOTOPES

Andreas Beinlich<sup>1</sup>, Timm John<sup>2</sup>, Masako Tominaga<sup>3</sup>, Tomas Magna<sup>4</sup> & Bjørn Jamtveit<sup>5</sup>

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<sup>3</sup> Dept of Geology and Geophysics, Texas A&M, USA

<sup>4</sup> Czech Geological Survey, Czech Republic; 5PGP, University of Oslo, Norway.

## TRACE ELEMENT AND ORGANIC MATTER INTERACTION IN KARST SYSTEMS

Adam Hartland<sup>1</sup>, Alison Blyth<sup>2\*</sup>, Andy Baker<sup>3</sup>

<sup>1</sup> Environmental Research Institute, Science and Engineering, University of Waikato, Hamilton, New Zealand

<sup>2</sup> The Institute for Geoscience Research, Department of Applied Geology, Curtin University, Perth, 6102, WA Australia

<sup>3</sup> Connected Waters Initiative Research Centre, University of New South Wales, Kensington, NSW, Australia 2052

## INCORPORATION OF SULFUR INTO EXTANT MICROBIALITES WITH ANCIENT GEOLOGICAL ANALOGUES

Matthew Campbell<sup>1</sup>, Kliti Grice<sup>1</sup>, Marco Coolen<sup>1</sup>, Paul Greenwood<sup>2</sup>, Lorenz Schwark<sup>3</sup>, Therese Morris<sup>4</sup>, Pieter Visccher<sup>5</sup>

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<sup>3</sup> Institute of Geosciences, Christian-Albrechts-Universität zu Kiel, Ludewig-Meyn-Str. 10, D-24118 Kiel,

<sup>4</sup> Applied Sedimentology & Marine Geoscience, Curtin University, Kent Street, Bentley WA 6102,

<sup>5</sup> Center for Integrative Geosciences, University of Connecticut, Storrs, CT, USA

## RELATIONSHIP BETWEEN DENSITY, VOLUME AND MASS TRANSFER DURING HYDRATION REACTION, BERGEN ARCS, NORWAY

Stephen Centrella<sup>1</sup>, Håkon Austrheim<sup>2</sup>, Andrew Putnis<sup>1,3</sup>

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<sup>2</sup> PGP, Department of Geosciences, University of Oslo, N-0316, Norway

<sup>3</sup> The Institute for Geoscience Research (TIGeR), Curtin University, Perth, 6102, Australia

## THE NORTH WEST SHELF OF AUSTRALIA: MOLECULAR AND ISOTOPIC APPROACH TO DISCRIMINATE ORGANIC FACIES AND THEIR POTENTIAL APPLICATIONS FOR FLUID – SOURCE ROCK CORRELATIONS

Jaime Cesar<sup>1</sup>, Ines Melendez<sup>2</sup>, Andrew Murray<sup>2</sup>, Kliti Grice<sup>1</sup>

<sup>1</sup> WA Organic and Isotope Geochemistry Centre, The Institute for Geoscience Research, Curtin University, Department of Chemistry, Perth, WA, Australia (E-mail: jaime.cesarcolmenares@curtin.edu.au).

<sup>2</sup> Woodside Energy Ltd., Perth, WA, Australia.

## CLIMATE OSCILLATIONS REFLECTED IN THE ARABIAN SEA SUBSEAFLOOR MICROBIOME

Marco J. L. Coolen<sup>1\*</sup>, William D. Orsi<sup>2,3</sup>, Lijun He<sup>4</sup>, Cornelia Wucher<sup>3</sup>, Kuldeep D. More<sup>1</sup>, Xabier Irigoien<sup>5</sup>, Guillem Chust<sup>6</sup>, Carl Johnson<sup>3</sup>, Jordon D. Hemingway<sup>3,7</sup>, Mitchell Lee<sup>3</sup>, Valier Galy<sup>3</sup> and Liviu Giosan<sup>8</sup>

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## HSE MOBILISATION IN SUBDUCTION ZONES: INSIGHTS FROM HIGH-PRESSURE SERPENTINITES AND ‘HYBRID’ ROCKS FROM ALPINE CORSICA

R.J. Crossley<sup>1\*</sup>, K.A. Evans<sup>1</sup>, N. Evans<sup>1,2</sup>, B. McDonald<sup>1,2</sup> & S.M. Reddy<sup>1</sup>

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## HYDROTHERMAL ALTERATION TEXTURES AND REE MINERALISATION IN THE CUMMINS RANGE CARBONATITE COMPLEX, KIMBERLEY REGION, WA

Peter J. Downes<sup>1</sup>, A. Lynton Jaques<sup>2</sup>, Michael Verrall<sup>3</sup>, Marcus T. Sweetapple<sup>4</sup>, Ian R. Fletcher<sup>5</sup>, Neal J. McNaughton<sup>6</sup>, Birger Rasmussen<sup>5</sup>

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<sup>6</sup> John de Laeter Centre for Isotope Research, Department of Applied Physics, Curtin University, Perth, WA 6945.

## DEPLOYMENT OF AN AUTOMATIC TREATMENT SYSTEM TO ACCELERATE MINERAL CARBONATION IN MINE TAILINGS AT WOODSREEF CHRYSOTILE MINE, NEW SOUTH WALES, AUSTRALIA

J.L. Hamilton<sup>1\*</sup>, S.A. Wilson<sup>1</sup>, B. Morgan<sup>1</sup>, C.C. Turvey<sup>1</sup>, A. Tait<sup>1</sup>, J. McCutcheon<sup>2</sup>, and G. Southam<sup>2</sup>

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<sup>2</sup> School of Earth Sciences, The University of Queensland, St Lucia, QLD 4072, Australia

## OPEN SYSTEM BEHAVIOUR WITHIN THE SEDIMENTS OF THE CORSICAN SCHISTES LUSTRÉS

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## <sup>834</sup>S OF ORGANIC SULFUR COMPOUNDS AND THE SULFUR CYCLE OF PETROLEUM SYSTEMS

Nannan He, Kliti Grice and Paul Greenwood

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## INVESTIGATION OF NI SEQUESTRATION DURING MANGANESE OXIDE MINERAL RECRYSTALLIZATION USING X-RAY ABSORPTION SPECTROSCOPY (XAS)

Tobias Hens<sup>1\*</sup>, Joël Brugger<sup>1</sup>, Barbara Etschmann<sup>1</sup>,

Susan Cumberland<sup>2</sup>, Andrew Friedrich<sup>1</sup>

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## DISTINGUISHING IN SITU STROMATOLITE BIOSIGNATURES FROM SILICIFICATION AND DOLOMITISATION USING SHORT WAVE, VISIBLE-NEAR AND THERMAL INFRARED SPECTROSCOPY: A MARS ANALOGUE STUDY

Sureyya H. Kose<sup>1\*</sup>, Simon C. George<sup>1</sup> and Ian C. Lau<sup>2</sup>

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<sup>2</sup> CSIRO, Australian Resources Research Centre (ARRC), 26 Dick Perry Avenue, Kensington, WA 6152, Australia

## VIRUS-PLANKTON INTERACTIONS DURING LONG-TERM CHANGES IN MONSOON-CONTROLLED OXYGEN MINIMUM ZONE (OMZ) EXPANSION IN THE ARABIAN SEA

Kuldeep More, Marco J.L. Coolen, Kliti Grice.

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## UNDERSTANDING NATURAL ANALOGUES OF MINERAL CARBONATION TO INFORM THE DEVELOPMENT OF INDUSTRIAL CO<sup>2</sup> STORAGE

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## CHEMICAL AND THERMAL EVOLUTION OF SUBDUCTION ZONES: INSIGHTS FROM TRACE-ELEMENT DISTRIBUTION AND LU-HF GEOCHRONOLOGY IN HP OCEANIC ROCKS, HALILBAĞI COMPLEX (CENTRAL ANATOLIA)

Amaury Pourteau<sup>1,2\*</sup>, Lisa Ebert<sup>2</sup>, Alexander Schmidt<sup>2</sup>, Erik E. Scherer<sup>3</sup> and Rebecca Bast<sup>3</sup>

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## FLUID INDUCED MICROSTRUCTURES IN GRANULITES FROM THE REYNOLDS RANGE, CENTRAL AUSTRALIA

Alexander M. Prent<sup>1</sup>, Andreas Beinlich<sup>1</sup>, Tom Raimondo<sup>2</sup>, Andrew Putnis<sup>1</sup>

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## BIOGEOCHEMICAL CONTROLS ON INVERTEBRATE BIODIVERSITY AND TROPIC RELATIONSHIPS WITHIN CALCARETE AQUIFERS IN THE YILGARN CRATON, WESTERN AUSTRALIA

Mattia Sacco<sup>1,2\*</sup>, Alison Blyth<sup>1,2</sup>, William Humphreys<sup>3</sup>, Bill Bateman<sup>4</sup>, Kliti Grice<sup>2</sup>

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## THE END CRETACEOUS MASS EXTINCTION EVENT RECOVERY AND EVOLUTION OF LIFE

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## MINERALOGY OF THE YANGIBANA LREE DEPOSIT, WESTERN AUSTRALIA

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## PALAEOENVIRONMENTAL CHANGES IN ORDOVICIAN SOURCE ROCKS OF THE CANNING BASIN, WESTERN AUSTRALIA

Gemma Spaak<sup>a\*</sup>, Kliti Grice<sup>a</sup>, Dianne Edwards<sup>b</sup>, Anais Pages<sup>c,a</sup>, Clinton B. Foster<sup>d</sup>, Roger E. Summons<sup>e</sup>

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## HYDROTALCITES AS A CARBON SINK IN SERPENTINITES

C.C. Turvey<sup>1\*</sup>, S.A. Wilson<sup>1</sup>, J.L. Hamilton<sup>1</sup>, J. McCutcheon<sup>2</sup>, A. Beinlich<sup>3,4</sup>, G.M. Dipple<sup>4</sup> and G.Southam<sup>2</sup>

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<sup>4</sup> Department of Earth, Atmosphere and Ocean Sciences, The University of British Columbia, Vancouver, BC V6T 1Z4, Canada

## MULTISCALE PETRO-STRUCTURAL STUDY OF THE MALINVERN-ARGENTERA MIGMATITE COMPLEX IN THE EXTERNAL COLLISIONAL ALPINE BELT

Silvia Volante<sup>1,2\*</sup>, Davide Zanon<sup>2</sup>, Maria Iole Spalla<sup>2</sup>

<sup>1</sup> Department of Applied Geology, Curtin University of Technology, WA, Australia

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## ARE POROSITY FORMING REACTIONS AN IMPORTANT INGREDIENT IN THE FORMATION OF OROGENIC GOLD DEPOSITS? AN INSIGHT FROM THE MICK ADAM GOLD DEPOSIT, YILGARN CRATON, WESTERN AUSTRALIA

James D. Warren<sup>1,2\*</sup>, Adam Bath<sup>3</sup>, Nicolas Thébauda, Christopher L Kirkland<sup>4</sup>, John Walshec

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## THE PATHWAY OF MINERAL REPLACEMENT OF GOLD TELLURIDES UNDER OXIDATIVE HYDROTHERMAL CONDITIONS INVESTIGATED BY IN SITU PXRD

Fang Xia<sup>1\*</sup>, Jing Zhao<sup>2</sup>, Allan Pring<sup>2</sup>, Joël Brugger<sup>3</sup>

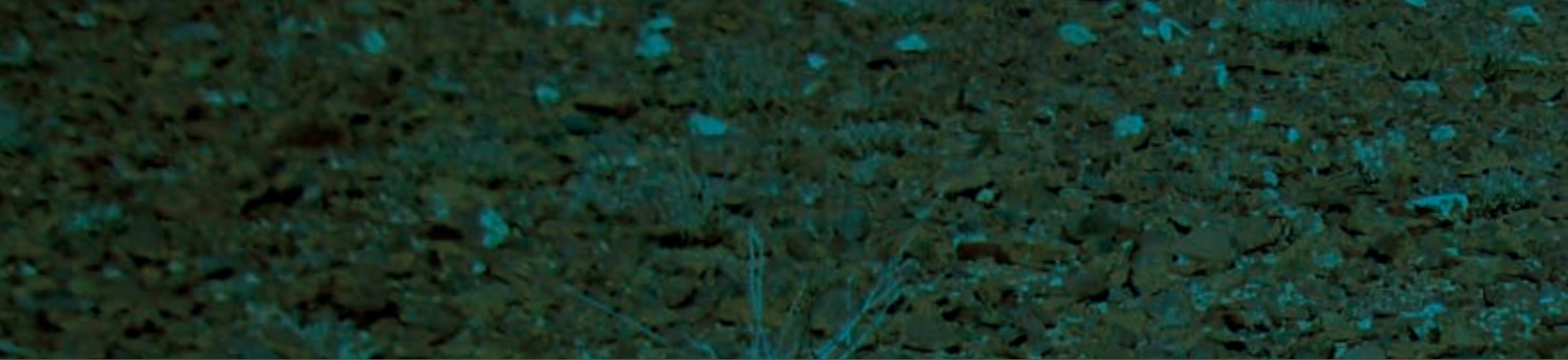
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