

## George Papageorgiou

Director, Epoch Resources (Pty) Ltd



mine residue and environmental engineering consultants

### BACKGROUND

George has worked in the mining related sector since 1994 specialising in the field of mine residue disposal and water management and specifically in the design, ongoing monitoring and associated environmental impacts of tailings residue disposal facilities and associated infrastructure.

George completed his BSc Eng (Civil) at the University of the Witwatersrand in 1991, followed by a MSc Eng (Civil) in 1994 at the same University in field of Unsaturated Soils. He then obtained employment with Steffan Robertson and Kirsten Consulting Engineers, working in the tailings department. In 1995 George returned to the University of the Witwatersrand to complete a PhD Eng (Civil) in the field of tailings liquefactions and flow slide failures. In 1999 he was employed by Metago Environmental Engineers where he designed and managed various residue disposal and environmental project. In 2003, George was appointed a Director of Metago and remained as such until 2005, when he resigned to start up Epoch Resources with his fellow partners.

George has been involved in all aspects of mine residue disposal projects in South Africa and internationally and his experience ranges from pre feasibility through to detail design, construction supervision and ongoing monitoring of such facilities, stochastic water and salt balances, tailings dam seepage assessments, liquefaction and flow slide assessments, storm water management and design, due diligences and technical reviews.

In addition to the technical aspects of mine residue disposal facilities, George has been involved in Environmental Impact Assessments and Environmental Management Reports, providing input on aspects pertaining to mine residue disposal such as seepage assessments, environmental management measures, closure, hydrology, storm water management and overall mine water balances.

### FIELDS OF COMPETENCE

Project Management of design team for mine residue disposal facilities and associated infrastructure, including water storage dams and stream diversions

Design of mine residue disposal facilities, conventional through to paste disposal (pre feasibility to detailed design)

Design of small and medium size water storage/effluent dams

Construction supervision

Stochastic water and salt balances

Seepage and slope stability analyses

Liquefaction assessments

Storm water management/control and design measures

Technical reviews and due diligences of mine residue disposal facilities

Ongoing monitoring and inspections of mine residue facilities

Unsaturated soils

### ACADEMIC QUALIFICATIONS

1991 – BSc Eng (Civil) University of the Witwatersrand;

1994 – MSc Eng (Civil) University of the Witwatersrand – Dissertation "Evaluation of Moisture Retention and Hydraulic Conductivity Characteristics of Unsaturated Soils";

2004 – PhD Eng (Civil) University of the Witwatersrand – Thesis "Liquefaction Assessment and Flume Modelling of the Merriespruit Gold and Bafokeng Platinum Tailings";

### PUBLICATIONS

Papageorgiou G (2004) "Liquefaction Assessment and Flume Modelling of the Merriespruit Gold and Bafokeng Platinum Tailings", PhD Eng (Civil) Thesis, University of the Witwatersrand, Johannesburg, South Africa, 2004

Fourie AB and G Papageorgiou (2001) "Defining an appropriate steady state line for Merriespruit gold tailings", Canadian Geotechnical Journal, Vol 38, pp 695-706.

Fourie AB, GE Blight and G Papageorgiou (2001) "Static liquefaction as a possible explanation for the Merriespruit tailings dam failure", Canadian Geotechnical Journal, Vol 38, pp 707-719.

Papageorgiou G, AB Fourie and GE Blight (1999) "Static liquefaction of Merriespruit gold tailings" Proceedings of the 12th regional conference for Africa on soil mechanics and geotechnical engineering, edited by GR Wardle, GE Blight and AB Fourie, South Africa, 25-27 October 1999.

Papageorgiou G, AB Fourie and GE Blight (1999) "Investigation of flow failures by means of a flume model", Tailings and Mine Waste 1999

Papageorgiou G, AB Fourie and GE Blight (1997) "An investigation of flow failures from breached tailings dams", Proceedings International Symposium on Engineering Geology and the Environment, Engineering

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Company Registration

Epoch Resources (Pty) Ltd, No 2005/007908/07

Directors

GJ Wiid, Dr. G Papageorgiou, A Savvas, SJP Coetzee

Geology and the Environment, edited by Marinos PG, Koukis GC, Tsiambaos GC and Stourmaras GC, Athens, Greece, 1997, pp 2477-2482

Papageorgiou G, AB Fourie and GE Blight (1997) "Flow failure and static liquefaction of tailings dams", Second International Conference on Mining and Industrial Waste Management, South Africa, 1997

Papageorgiou G (1997) "Investigation of breached tailings dams and flow failures" Civil Engineering, South African Institute of Civil Engineering, February, pp 18-20

Papageorgiou G (1996) "Investigation of breached tailings dams and flow failures" Young Water, Environmental and Geotechnical Engineers Conference, Bothas Hill, South Africa, 1996

Fourie AB, G Papageorgiou and GE Blight (1995) "The rapid determination of the moisture retention characteristics of soils" American Society for Testing and Materials, pp 276-285

Fourie AB and G Papageorgiou (1995) "A technique for the rapid determination of the moisture retention relationship and hydraulic conductivity of unsaturated soils", Proceedings of the First International Conference on Unsaturated Soils, edited by EE Alanso and P Delage, UNSAT'95, Paris, France, 1995, pp 485-490

Papageorgiou G (1994) "Evaluation of the moisture retention and hydraulic conductivity characteristics of unsaturated soils", MSc Eng (Civil) Dissertation, University of the Witwatersrand, Johannesburg, South Africa, 1994

Papageorgiou G (1993) "Laboratory investigation of the flow of water in saturated/unsaturated soils", Second Southern African Young Geotechnical Engineers Conference, Stellenbosch, South Africa, 1993

## KEY PROJECTS NATIONALLY

### ST HELENA 2,3,& 4 GOLD TAILINGS DAM – DETAIL DESIGN AND CONSTRUCTION SUPERVISION – 2009 TO 2010;

Design of a residue disposal facility comprising of:

- Cycloned, conventional self raising tailings storage facility over an existing re-mined tailings dam footprint; and
- Return Water and Storm Water Dams;

Project management of the ground water study associated with the project and liaising with the DWAF

Tender Adjudications

Construction supervision and management

### WESTERN BUSHVELD JOINT VENTURE PLATINUM MINE – BANKABLE FEASIBILITY – 2008;

Design of a residue disposal facility comprising of:

- Thickened tailings, conventional self raising tailings storage facility;
- Return Water and Storm Water Dams; and
- Waste Rock Dump

### MOOIHOEK CHROME MINE – BANKABLE FEASIBILITY DESIGN – 2008;

Design of a residue disposal facility comprising of:

- Conventional tailings, conventional self raising tailings storage facility;
- Return Water and Storm Water Dams; and
- Waste Rock Dump

### VOORSPOED DIAMOND MINE – CONCEPTUAL TO BANKABLE FEASIBILITY DESIGN 2004- 2005

Conceptual and Bankable feasibility design of:

- Paste disposal tailings storage facility
- Return Water and Storm Water Dams;
- Coarse Tailings Dry Disposal Dump;

Project manager of the following additional studies:

- Environmental Impact Assessment;
- Mine's bulk water supply study comprising groundwater and water supply from Agricultural Dam 45km from mine;
- Acquisition of existing water rights and converting them from agricultural to industrial/mining water use;

### TROJAN (MARULA) PLATINUM MINE – BANKABLE FEASIBILITY DESIGN AND DETAIL DESIGN STREAM DIVERSION CHANNEL -2002

Design of a residue disposal facility comprising of:

- Thickened tailings, waste rock containment tailings storage facility;
- Return Water and Storm Water Dams; and
- Waste Rock Dump

Hydrological assessment and detail design of a stream diversion channel for the mine

### DEBEERS DIAMONDS – GEOTECHNICAL ASSESSMENT OF PASTE – 2001

Assessment of the tailings deposition and seepage regime characteristics of thickened paste and thickened co disposal kimberlite tailings by means of geotechnical and large scale flume tests for the application in tailings storage facility design.

### DWARSRIVIER CHROME MINE – DETAIL DESIGN AND CONSTRUCTION SUPERVISION – 1999 TO 2001

Detail design of:

- Conventional tailings, conventional self raising tailings storage facility;
- Return Water and Storm Water Dams;
- Dry Dense Medium Separation Dump;

Development and assessment of overall mine water management strategy, mine water and salt balance

Construction supervision and management

## KEY PROJECTS INTERNATIONALLY

### TONGON GOLD MINE – IVORY COAST – DETAIL DESIGN AND CONSTRUCTION SUPERVISION – 2009 TO 2010

Detail design of:

- Thickened tailings, valley containment tailings storage facility;
- Return Water and Storm Water Dams;
- 35 million m<sup>3</sup> Water Supply Dam; and
- 3.0 km Stream Diversion Channel

Construction supervision and management

**BOKAI PLATINUM MINE – ZIMBABWE – BANKABLE FEASIBILITY DESIGN – 2009**

Bankable feasibility design of:

- Thickened tailings, valley containment tailings storage facility; and
- Associated Return Water and Storm Water Dams;

**LOULO MINE – GOLD MINE – MALI – MONITORING AND MISCELLANEOUS DESIGN – 2007 TO DATE**

Ongoing quarterly monitoring and inspection of residue disposal facility;

Miscellaneous designs associated with the ongoing development of the residue disposal facility e.g.:

- Raising of earth containment wall;
- Emergency spillways;
- Installation of piezometers

**TATI NICKEL MINE – DETAIL DESIGN AND ONGOING MONITORING OF RESIDUE DISPOSAL FACILITY - BOTSWANA – 2001 - TO DATE**

Detail design of:

- Thickened tailings, conventional self raising tailings storage facility;
- Return Water and Storm Water Dams;
- Stream diversion;

Ongoing quarterly monitoring and inspection of residue disposal facility;

Miscellaneous designs associated with the ongoing development of the residue disposal facility e.g.:

- Implementation of dewatering well field to increase water recovers;
- Implementation of water saving strategies resulting in 65%-75% recoveries and return of slurry water deposited on the residue disposal facility;
- Installation of piezometers

**LIQOBONG DIAMOND MINE – LESOTHO – DETAIL DESIGN – 2004**

Detail design of:

- Conventional tailings, valley containment tailings storage facility;
- Return Water;
- Storm water management measures;
- Seismic assessment of stability of main valley embankment;

**TONGON GOLD MINE – IVORY COAST – BANKABLE FEASIBILITY DESIGN – 2008**

Bankable feasibility design of:

- Thickened tailings, valley containment tailings storage facility;
- Return Water and Storm Water Dams;
- Main mine water supply/storage dam

**TATI NICKEL MINE – BOTSWANA - DETAIL DESIGN OF DENSE MEDIUM SEPARATION DUMP – 2008**

Detail design and construction supervision of a 750,000 t/month dry DMS disposal dump including associated water management dams;

Project Management of Environmental Impact Assessment and Approvals for the DMS Dump

**PERKOA ZINC MINE – BURKINA FASO – BANKABLE FEASIBILITY TO DETAIL DESIGN – 2005 TO 2008**

Bankable feasibility design of:

- Lined residue storage ponds;
- Return Water and Storm Water Dams;
- Dense Medium Separation Dry Dump;

Project management of:

- Environmental Impact Assessment;
- Ground Water Studies;

Detail design of:

- Lined residue storage ponds;
- Return Water and Storm Water Dams;
- Dense Medium Separation Dry Dump;
- Domestic Landfill facility;
- Slope stability assessment of mine box cut side slopes

**VALENCIA URANIUM MINE – NAMIBIA – PRE FEASIBILITY AND FEASIBILITY DESIGN – 2007 & 2008**

Pre feasibility and feasibility design of:

- Dry tailings dump;
- Return Water and Storm Water Dams

**LUANSHYA COPPER MINE – ZAMBIA – TECHNICAL REVIEW - 2007**

Technical assessment and review of tailings disposal facility

**WILLIAMSON DIAMOND MINE – TANZANIA – 2006 & 2007- CONCEPTUAL AND PRE FEASIBILITY DESIGN**

Conceptual design of:

- Conventional tailings, conventional self raising and full containment tailings storage facility;
- Return Water and Storm Water Dams;
- Dry disposal tailings dump;

Preliminary assessment of water storage capacity and water balance associated with mine's main water supply dam

Pre feasibility design of:

- Conventional tailings, full containment tailings disposal facility using mine waste rock material;
- Return Water and Storm Water Dams;

**ARGYLE DIAMOND MINE –AUSTRALIA – 2001- LIQUEFACTION ASSESSMENT**

Determination and assessment of the liquefaction susceptibility of the Argyle tailings used in the construction of the tailings storage facility main containment embankment.

**ARGYLE DIAMOND MINE –AUSTRALIA – 2000- STOCHASTIC MINE WATER BALANCE**

Development of detailed overall mine stochastic water balance

**ARGYLE DIAMOND MINE –AUSTRALIA – 1999- RISK ASSESSMENT**

Development of fault/event tree to determine overall risk of tailings storage facility