ANDREW ROBERTSON, Ph.D., P.Eng.

PRESIDENT

EDUCATION

Ph.D., Engineering (Rock Mechanics), University of Witwatersrand, South Africa, 1977
B.Sc., Civil Engineering, University of Witwatersrand, South Africa, 1966

PROFESSIONAL REGISTRATION

Professional Engineer, APEGBC, APEGA, APEGS, PEO

EXPERIENCE

SUMMARY

Dr. Robertson as founder and president of Robertson GeoConsultants Inc. (RGC), and prior to that SRK Consulting, has been directly responsible for a wide range of mining, geotechnical and environmental engineering projects for the mining industry and government clients, including site investigations and foundation design, rock mechanics and soil slope stability for open pit mines; design of a wide variety of tailings impoundments; and waste dump investigations and designs, including acid rock drainage (ARD) evaluations and control, mine closure plan development and risk assessment.

He has been the lead investigator and/or designer for numerous project teams for mining companies and provides review and senior evaluation and counseling to a number of mining companies, research establishments, professional associations and provincial, state and federal agencies. Dr. Robertson participates on numerous technical review boards for tailings and mine waste facilities for mining companies and regulatory authorities. He has published extensively, participated in the drafting of numerous technical guides currently used by industry and regulatory bodies alike, and has been the recipient of a number of technical and industry awards. He has performed numerous dam safety inspections and environmental liability assessments for tailings and water dams, mine waste dumps and mining properties.

Projects have been undertaken in Canada, the USA, Germany, France, Sweden, Norway, the Czech Republic, Chile, Brazil, Argentina, Peru, Guatemala, Australia, Philippines, Vietnam, South Africa, Mali, Namibia and Papua.

PROFESSIONAL HISTORY

2021 to present: President (Emeritus), Robertson GeoConsultants (RGC) Inc. (Canada)

Dr. Robertson continues his practice as corporate consultant to the international mining industry, with focus on participation in several Technical Review Boards for tailings and mine waste facilities.

1994-2021: Founder and President, Robertson GeoConsultants (RGC) Inc. (Canada)

Dr. Robertson continued his practice started in SRK Consulting as RGC with increasing specialization in decision make and risk assessment for mining projects, and increased

participation in numerous Technical Review Boards for tailings and mine waste facilities and mining geotechnics.

1977-1994: Founding Partner and Corporate Consultant, SRK Consultants Inc. Canada

Opening the first branch of Steffen, Robertson and Kirsten in Canada, Dr. Robertson continued with the development of this engineering firm (became SRK Consulting) performing primarily mining geotechnical and civil engineering. Dr Robertson lead the mining geotechnical practice in tailings and mine waste dams, rock slope engineering, geochemistry, environmental impact management and risk assessment. Under his management offices were opened at various locations in the USA and Canada.

1973-1977: Founding Partner and Principal, Steffen Robertson and Kirsten Inc. – South Africa

Dr. Robertson developed and managed the consulting geotechnical and civil engineering practice in South Africa where he was responsible for the Soils Division performing geotechnical investigations and designs for a wide variety of buildings foundations, road, rail and water pipeline corridors and associated geotechnical engineering works, tailings dams and rock slope engineering.

1969-1973: Chief Engineer, Frankipile (S.A.) Ltd. Specialist foundations investigations & design

1968: Research Officer, De Beers Consolidated Mines Rock slope stability studies and stabilization design for the De Beers pit.

During his career in consulting Dr. Robertson was also the founder of the mine planning software firm Gemcom Inc. and the Internet mining information company InfoMine Inc.

PROJECT EXPERIENCE (SELECTED STUDIES)

REVIEW BOARDS

- CODELCO 10 Tailings dams at Andina, El Teniente, Chuquicamata and Salvador Divisions (2016 to present). Member of 5 man Review Board
- Suncor Mine, 2013 to 2020 – Member of 4 man Mine Development and Reclamation Review Board for all major geotechnical structures including tailings dams, waste dumps and water management structures for very large oil sands mining complex (>400,000 tpd) in Alberta, Canada. Suncor Inc.
- Diavik Mine, 2001 to 2018 – Member of 5 man Independent Dike Review Board for the review of all technical, construction and safety issues for the construction of a 3 dikes totaling 8 km, and up to 30 m deep to enable the mining of the Diavik diamond pipe deposits by open pit mining methods within a lake, for Diavik Diamond Mines Inc., Northwest Territories, Canada. Diavik Diamonds Inc.
- Antamina Mine, 1999 to 2017 – Member of 4 man Independent Geotechnical and Tailings Review Board for open pit, waste dumps, acid drainage management, access road and 265 m high staged concrete faced rock fill tailings dam in Peru (140,000 tpd copper/zinc mine, Compania Minera Antamina S.A.).
- Cerra Corona Mine, 2006 to 2017 – 40,000 tpd copper - Member of 4 man Independent Geotechnical and Tailings Review Board for 165 m high rockfill tailings dam constructed using centerline methodology with extensive construction also of infiltration control blankets to prevent contaminated drainage to karstic limestone formations. Goldfields

- Cerro Verde Mine, 2003 to present - on two separate IGTRB's for two very large cyclone sand tailings dams (Enlozada dam 285 m and Linga dam 310 m under the crest) for tow concentrator plants (140,000 tpd and 280 tpd) copper mines. The Linga dam has a 160 m high Starter Dam and will be 430 m high (measured according to ICOLD) on completion, making it the highest dam under construction in the world. Freeport.
- Member of a 6 man Independent Peer Review Panel (2008 to present) for the remediation and closure of abandoned mines in the Yukon and Northwest Territories, Canada. Numerous mines with associated mine workings, tailings dams, waste dumps are involved. Largest projects include the Faro Mine open pit lead zinc mine and Giant Mine gold mine, each with closure costs estimated to exceed 500 million dollars. Canadian Department of Indian and Northern Development.
- Phu Bia (40,000 tpd copper) and Banhuaxi (20,000 tpd gold) Mines in Laos. Member of 3 man Review Board (2010 to 2018) for rock and earthfill tailings dams. 2009 to present. PanAust
- Frieda Project (90,000 tpd copper) 2015 to 2017 – 260 m high tailings dam in Papua New Guinea – PanAust
- Raura, Peru (8,000 tpd gold/copper), San Rafael, Peru (8,000 tpd tin) and Pitinga (25,000 tpd tin), Brazil. 3 member Review Board for tailings dams and hydro-electric dam.(2013 to 2018). Minera Minsur.
- Syncrude Mine (2000 to 2010) – Member of 7 man Syncrude Landscape Restoration Technical Advisory Panel for review of program of research, development and application of reclamation technology for restoration and mine closure, Alberta, Canada, processing over 400,000 tpd of oil sands. Syncrude.
- Compania Vale Do Rio Doce (CVRD) 2002 to 2013 - Senior auditor on team reviewing and auditing all tailings, sediment and water storage dams, as well as waste rock dumps on all CVRD mines in Brazil (over 100 dams and major geotechnical structures).
- Vale, Sudbury 2009 to 2020. – Member of 4 man Review Board for Copper Cliff tailings facility (copper nickel) that has been in operation for almost 100 years with over 30 tailings and water dams. CVRD
- Samarco Mine (1998 to 2012) - Technical Reviewer and Auditor for all tailings dams and waste rock piles for this large iron ore mining complex in Brazil (Samarco Mineração, S.A.). Tailings Review Board member from 2010 to 2012.
- Fort Knox Mine – 1998 to 2002 One man Technical Review Board for tailings and water dams on behalf of Division of Dam Safety, Alaska Dept of Natural Resources, Alaska, USA.
- Illinois Creek Mine 1995 to 2000 - One man Technical Review Board for heap leach facilities on behalf of Division of Dam Safety, Alaska Dept of Natural Resources, Alaska, USA.
- Richmond Hill Mine Waste Remediation (1995 -1997) - One man Technical Review Board for mine waste and heap leach facilities reclamation and closure on behalf of South Dakota Dept of Natural Resources, South Dakota, USA.
- American Arbitration Association (AAA) – Senior arbitrator in arbitration case relating to tailings dam construction for Homestake Mining Company, Lead, South Dakota, USA.
- Mine Waste Pilot Program – Member of three man Technical Advisory Board for this US EPA funded Research program for better management of mine wastes, in Butte, Montana, USA. 2000 - 2003
- Geological Engineering Program University of British Columbia – Chairman of Board of Studies, B.C., Canada. 1995 - 2000
- Miscellaneous Reviews/Audits – Performed over 100 other individual tailings dam, water dam, major geotechnical structure, closure plan and environmental liability reviews and

audits for mining companies, financial institutions and regulatory agencies in over 20 countries.

TECHNICAL GUIDES

- Draft Acid Rock Drainage Technical Guide, Volumes I & II
- Rehabilitation of Mines - Guidelines for Proponents
- Mine Rock Guidelines - Design and Control of Drainage Water Quality
- Mine Reclamation in the Northwest Territories and the Yukon
- Guidelines for ARD Prediction in the North
- Waste Disposal Technology Manual
- Acid Generation and Metal Leaching from Solid Mine Waste
- Uranium Mill Waste Disposal Technology Manual
- In Situ Testing for Geohydrological Investigations of Tailings Dams
- EnviroMine and EduMine on the World Wide Web

AWARDS

The R.M. Hardy Award presented by the Canadian Geotechnical Society in recognition of Dr. Andrew Robertson's contribution to Canadian Geotechnique through the preparation and presentation of the Allocation R.M. Hardy Keynote Address. This Award was presented at the 48th Annual Canadian Geotechnical Conference, Vancouver, September 1995.

Excellence Award from the Consulting Engineers Council of Colorado to Woodward-Clyde Consultants and Steffen, Robertson & Kirsten for Island Copper Seepage Barrier Wall, Vancouver Island, British Columbia, 1992.

Honor Award from the American Consulting Engineers Council to Woodward-Clyde Consultants and Steffen, Robertson & Kirsten for Island Copper Seepage Barrier Wall, Vancouver Island, British Columbia, 1992.

Merit Award for Andrew Robertson's distinguished contribution to the Mine Environmental Neutral Drainage (MEND) Program and the British Columbia Acid Mine Drainage (BCAMD) Task Force in addressing the industrial and public concern of the impact of mining on the environment. Presented at the Second International Conference on the Abatement of Acidic Drainage, Montreal, Canada, 1991.

Environmental Engineering Design Award from the Association of Professional Engineers of British Columbia to Andy Robertson, Graham Baldwin and John Barton-Bridges for outstanding achievement in environmental engineering design, 1990.

SELECTED PUBLICATIONS

Robertson, A. MacG. and Shaw, S. (2004): The Multiple Accounts Analysis of Pit Backfilling. Presentation published in Proceedings of the 12th Annual Mine Design, Operations & Closure Conference, Polson, Montana, USA, 25-29 April, 2004.

Robertson, A. MacG., and Shaw, S. (2004): "Use of the Multiple Accounts Analysis Process for Sustainability Optimization". In Proceedings of the SME Annual Meeting, Denver, Colorado, USA, 23-25 February, 2004.

Wels, C., Robertson A. MacG., Madariaga, P.M. (2004): "Water Recovery Study for Pampa Pabellon Tailings Impoundment, Collahuasi, Chile". In proceedings of the 11th Annual Conference on Tailings and Mine Waste, Vail, Colorado, USA, 10-13 October, 2004.

Robertson, A. MacG., Llyod, T., and Robins, M. (2003): Residue Disposal at Sadiola Hill Gold Mine: Stability Evaluation by Field Testing. In Proceedings of the International Mining Conference, Johannesburg, SA, 2003.

Wels, C. and Robertson, A. MacG. (2003). Conceptual model for estimating water recovery in tailings. In proceedings of the 10th International Conference on Tailings and Mine Waste, Vail, Colorado, USA, 12-15 October 2003, pp. 87-94.

Robertson, A. MacG., and Shaw, S.C. (2003). *Ri*sk management for major geotechnical structures on mines. In proceedings of Computer Applications in the Mineral Industries (CAMI), Calgary, Alberta, Canada, 8-10 September 2003.

Jakubick, A., McKenna, G., and Robertson, A. (2003). Stabilisation of Tailings Deposits: International Experience. In proceedings of Mining and the Environment III, Sudbury, Ontario, Canada, 25-28 May, 2003.

Shaw, S., Wels, C., Robertson, A., Fortin, S., and Walker, B. (2003). “Background characterization study of naturally occurring acid rock drainage in the Sangre de Cristo Mountains, Taos County, New Mexico”, In proceedings of the Sixth International Conference on Acid Rock Drainage, Cairns, Queensland, Australia, 14-17 July, 2003, pp. 605-616.

Wels, C., Lefebvre, R., and Robertson, A. (2003). An Overview of Prediction and Control of Air Flow in Acid-Generating Waste Rock Dumps. In proceedings of the Sixth International Conference on Acid Rock Drainage, Cairns, Queensland, Australia, 14-17 July, 2003, pp. 639-650.

Shaw, S.C., Wels, C, Robertson, A. MacG and Lorinczi, G. (2002). Physical and Geochemical Characterization of Mine Rock Piles at the Questa Mine, New Mexico: An Overview. In Tailings and Mine Waste '02, proceedings of the Ninth International Conference on Tailings and Mine Waste, Fort Collins, Colorado, USA, 27-30 January 2002, pp. 447-458.

Lefebvre, R., Lamontagne, A. Wels, C., & Robertson, A. MacG. (2002). ARD Production and Water Vapor Transport at the Questa Mine. In Tailings and Mine Waste '02, proceedings of the Ninth International Conference on Tailings and Mine Waste, Fort Collins, Colorado, USA, 27-30 January 2002, pp. 479-488.

Shaw, S.C. and Robertson, A. MacG. (2001). *Geochemical Predictions of the Landusky Spent Ore Heap Leach Pads and Implications for Water Management*. Presented at the British Columbia ARD Workshop, November, 2001.

Shaw, S.C, Robertson, A. MacG., Maehl, W.C., Kuipers, J. and Haight, S. (2001). Review of the Multiple Accounts Analysis Alternatives Evaluation Process Completed for the Reclamation of the Zortman and Landusky Mine Sites. Paper submitted for presentation at the National Association of Abandoned Mine Lands Annual Conference, August 19-22, 2001, Athens, Ohio.

Wels, C., A. MacG. Robertson and A. T. Jakubick, (2000). “A Review of Dry Cover Placement on Extremely Weak, Compressible Tailings, Paper presented at Sudbury ’99 – Mining and the Environment II; Conference held September 13th–15th , 1999, Sudbury, Ontario.

Wels, C., A. MacG. Robertson and A. T. Jakubick. (1999). “A Review of Dry Cover Placement on Extremely Weak, Compressible Tailings”, CIM Bulletin 93 (1043): pp. 111-118. September 2000.

Wels, C., A. MacG. Robertson and A. T. Jakubick. (1999). “Cover Placement on Extremely Weak, Compressible Tailings, Paper presented at the Soft Tailings Stabilization Workshop, May 26th–27th, 1999, Edmonton, Alberta.

Robertson, A. MacG. And Shaw, S.C. (1999). The Concept of Custodial Transfer of Mined Land. In Proceedings of Mine, Water & Environment, Seville Spain, September 13-17, 1999. Vol 1, pp 765-771.

Shaw, S., Robertson, A. MacG., and Maehl, W.C. (1999). Material Characterization and Prioritization of Remedial Measures at the Zortman/Landusky Mine Sites. In Proceedings of the 2000 Billings Land Reclamation Symposium, Billings, Montana, March 20-24, 2000, pp. 346-358.

Robertson, A. MacG. and Shaw, S.C. (1999). A Multiple Accounts Analysis for Tailings Site Selection. In Proceedings of Sudbury ’99 Mining and the Environment, Vol. 3, pp. 883-892.

Wels, C. and A.MacG. Robertson, 1998. “Assessment and management of Risks relating to Covers for Metal Leaching and Acid Migration”, Paper presented at the 5th Annual BC Metal Leaching/ARD Workshop, December 9 - 10th 1998, at Vancouver, BC.

Robertson, Andy MacG. and Shaw, Shannon C. (1998). *Alternatives Analysis for Mine Development and Reclamation. In Mine Reclamation and Remediation*, Proceedings of the Twenty-second Annual British Columbia Mine Reclamation Symposium, Pentiction, B.C., Sept. 14-17, pp. 51-62.

Robertson, Andy MacG., Shaw, Shannon C. and Devenny, David (1998). *Post Mining Sustainable Use Plans vs Closure Plans*. In Mine Reclamation and Remediation, Proceedings of the Twenty-second Annual British Columbia Mine Reclamation Symposium, Pentiction, B.C., Sept. 14-17, pp. 95-110.

Robertson, Dr. A. MacG., Broughton, Linda and Shaw, Shannon (1998). *Acid Rock Drainage; Its Assessment, Prediction and Control*. Short Course Presented to the United States Environmental Protection Agency, Region 10, Seattle, WA, October 14-15.

Jakubick, A.T., Gatzweiler, G., Mager, D. and Robertson, A. MacG. (1997): "The WISMUT Waste Rock Pile Remediation Program of the Ronneburg Mining District, Germany". In Proceedings of the Fourth International Conference on Acid Rock Drainage, vol. III, p. 1285-1302.

Robertson, A. MacG. and Shaw, S.C. (1997): "Options for the Stabilization of Sludges from Acid Mine Drainage Water Treatment Plants." Proceedings of the Wismut 97 Workshop, Wismut, Germany, September 23, 1997, 11 pp.

Robertson, A. MacG. (1996): "The Importance of Site Characterization for Remediation of Abandoned Mine Lands". Seminar Publication of the U. S. EPA Managing Environmental Problems at Inactive and Abandoned Metals Mine Sites.

Robertson, A. MacG. and Rohrs, R.G. (1995): "Sulfate Removal of Acid Mine Drainage Water After Lime Treatment". Proceedings of the Sudbury '95 Conference on Mining and the Environment, Sudbury, Ontario, May, 1995, vol. II, p 575-586.

Mathis, J.I., Robertson, A. MacG. and Robertson, R.B. (1993): "Innovative Mine Design for the 21st Century". Proceedings of the International Congress of Mine Design; Kingston, Ontario, August 23-26, 1993.

Mathis, J.I., Robertson, A. MacG. and Robertson, R.B. (1993): "Mining below sea level: Design and performance of the south slope expansion at Island Copper". Proceedings of the International Congress on Mine Design, Kingston, Ontario, Canada, August 24-26.

Chapman, J., Hockley, D., Robertson, Robertson, A. MacG. and Broughton, L. (1993): "Rock Pile Water Quality Modelling - The Q-ROCK Mathematical Model". Presented at the Environmental Management for Mining Conference, Saskatoon, October 27-29.

Broughton, L.M. and Robertson, A. MacG. (1992): "Reliability of ARD Testing". Workshop on U.S. EPA Specifications for Tests to Predict Acid Generation from Non-Coal Mining Wastes, Las Vegas, Nevada, July 30-31.

Broughton, L.M. and Robertson, A. MacG. (1992): "Acid Rock Drainage From Mines - Where We Are Now". IMM Minerals, Metals and Environment Conference, Manchester, U.K., February 4-6.

Brodie, M.J., Robertson, A. MacG., Gadsby, J.W. (1992): "Cost Effective Closure Plan Management for Metal Mines" . 16th Annual Mine Reclamation Symposium, Smithers, B.C., June 15-18.

Brodie, M.J., Broughton, L.M. and Robertson, A. MacG. (1991): "A Conceptual Rock Classification System for Waste Management and a Laboratory Method for ARD Prediction from Rock Piles". Second International Conference on the Abatement of Acidic Drainage, Montreal, September 16-18.

Broughton, L.M. and Robertson, A. MacG. (1991): "Modelling of Leachate from Acid Generating Waste Rock Dumps" . Second International Conference on the Abatement of Acidic Drainage, Montreal, September 16-18.

Robertson, A. MacG. and Robertson, R.B. (1990): "Geotechnical Considerations in the Design of the Island Copper Mine South Wall Pushback". International Symposium on Mine Planning and Equipment Selection in Surface Mining, the University of Calgary, November 7-9.

Robertson, A. MacG. and Barton-Bridges, J.P. (1990): "Cost Effective Methods of Long Term Acid Mine Drainage Control from Waste Rock Piles". GAC-MAC Conference, Vancouver, May.

Healey, P.M. and Robertson, A. MacG. (1989): "A Case History Of An Acid Generation Abatement Program For An Abandoned Copper Mine". Canadian Land Reclamation Association and the American Society of Surface Mining and Reclamation, Calgary.