REFERENCES - SELECTED BIOGRAPHY

1. Takahashi.K, Sekikawa.A.La Porte.R.E. *et al.* Occupational lung diseases and global occupational health on the Net. Occup. Med.1998; **48(**1): 3-6.

2. Swiegers WRS, Yach B, Von Schirnding Y, Seager J, Schutte C, Terblanche, NPS. The South African Medical Council's Submission to the CSIR for the United Nations Conference on Environment and Development. 1991. Aug.

3. Swiegers WRS, Terblanche APS. von Schirnding Y. Medical Research Council's (RIED) Submission to the President's Council for the Formulation of a National Environmental Management System. 1990. Nov.

4. Erlich R. Occupational medical surveillance. S Afr Med. J. 1996; **14(**9): 1301-1310.

5. Samet JM, Utell, MJ. The Environment and the Lung - Changing Perspectives. JAMA. 1991; **266** (5): 670-675.

6. Christian DC. Occupational Respiratory Disorders and Occupational Exposures in South Africa. S Afr J Cont Med Educ .1996; **14**(9): 1338-1344.

7. Tomatis L. How Many Cancers Are Attributable To Occupational Exposures? Int Agency Research on Cancer. 1991. **46** (1): 5.

8. De Klerk NH. Musk WA. Silica, Compensated Silicosis and Lung Cancer in Western Australian Goldmines. Occup Environ Med. 1998; **55**: 243-248.

9. Fry RM. Radiation Hazards in Uranium Mining and Milling. Atomic Energy, 1975; **8:** 12-31.

10. Archer VE, Gillam JD, Wagoner JK. Respiratory disease mortality among uranium miners. Ann NY Aca Sci 1976; **271**: 280-293.

11. Archer VE. Health Concerns In Uranium Mining and Milling. J Occup Med; 1981; **23**(7): 502-5.

12. Vich Z, Oacuba V. Lung Carcinoma in Uranium Miners, Czechoslovakia 1976 - 1980. Neoplasma; 1987; **34**(2): 211-215.

13. Samet JM. Diseases of Uranium Miners and Other Underground Miners Exposed to Radon. In: Rom W H ed. Environmental and Occupational Medicine. 2nd ed. Boston. Little, Brown&Company. 1992; 1085-1090

14. Tomasek L, Swerdlow AJ, Darby SC, Placek V, Kunz E. Mortality in Uranium Mines in West Bohemia : A Long Term Cohort Study. J Occup Environ Med. 1994; **51**: 308-315.

15. Kussiak RA, Ritchie AC, Mueller J, Springer J. Mortality from Lung Cancer in Ontario Uranium Mines. Br J Ind Med. 1993; **50**: 920-928.

16. Servc J, Kunz E, Tomasek L, Placek V, Horacek J. Cancer in Man after Exposure to RN Daughters, Health Phys. 1988; **54**(1): 27-46.

17. Vich Z, Dienstbier Z. Risks of Malignant Neoplasm's in Workers in Czechoslovak Uranium Mines. Sb Lek, 1991; **93** (7-8) : 227-31.

18. Hornug RW, Meinhardt TJ. Quantitative Risk Assessment of Lung Cancer in U.S. Uranium Miners. Health Phys., 1987; **52** (4): 417-30

19. Jacobi W, Paretzke HG. Risk Assessment for Indoor Exposure to Radon Daughters. Sci Total Environ, 1985**; 45**: 551-62.

20. Ginevan ME, Mills WA. Assessing the risks of Radon exposure: the influence of cigarette smoking. Health Phys. 1985; **51**(2): 163-74.

21. Cohen BL. Radon Daughter Exposure to Uranium Miners. Health Phys. 1982; **42**(4): 449-457.

22. Sevc J, Kunz E, Tomäsek L, Pläcek V, Joräcek J. Cancer in Man after Exposure to Radon Daughters. Health Phys., 1988; **54**(1): 27-46.

23. Roscoe RJ, Steenland K, Halperin WE, Beaumont JJ, Waxwellier JJ. Lung Cancer Mortality among Nonsmoking Uranium Miners Exposed to Radon Daughters. JAMA. 1989; 262(5): 629-33.

24. L'Abbe K, Howe GR, Burch J, Miller AB, Abbatt J, Band P, Choi W, Du J, Feather J, Gallagher R. Radon Exposure, Cigarette Smoking, and Other Mining Experience in the Beaverlodge Uranium Miners Cohort. Health Phys. 1991; **60** (4): 489-95.

25. Woodward A, Roder D, Mc Michael AJ, Crouch P, Mylvaganam A. Radon Daughter Exposures at the Radium Hill Uranium Mine and Lung Cancer Rates Among Former Workers, 1952-87. Cancer Causes Control, 1991; **2**(4): 213-220.

26. Samet JM. Diseases of Uranium Miners and Other Underground Miners Exposed to Radon. J Occup Med., 1991; **6**(4): 629-39.

27. Abelson PH (Ed). Mineral Dusts and Radon in Uranium Mines. Science, 1991; **254** (5033); 777.

28. Samet JM, Pathak DR, Morgan MV, Key CR, Valdivia AA, Lubin JG. Lung Cancer Mortality and Exposure to Radon Progeny in a Cohort of New Mexico Underground Uranium Miners. Health Phys., 1991; **61**(6): 745-52.

29. Moolgavkar SH, Luebeck EG, Krewski D, Zielinski JM. Radon, Cigarette Smoke and Lung Cancer: A Re-Analysis of the Colrado Plateau Uranium Miners Data. Epidemiology, 1993; **4**(3): 204-17.

30. Tomasek L, Darby S, Swerdlow A, Placek V, Kunz E. Radon Exposure and Cancers Other Than Lung Cancer Among Uranium Workers in West Bohemia. Lancet. 1993; **341**(8850): 919-923

31. Steenland K. Age Specific Interaction Between Smoking And Radon Among United States Uranium Workers.J Occup Environ Med. 1994; **51**(3) : 192-4

32. Samet JM, Pathak DR, Morgan MV, Couttas DB, James DS, Hunt WC. Silicosis And Lung Cancer In Underground Uranium Miners. Health Phys.1994; **66** (4): 450-453.

33. Hnizdo E. Health risks among white South African goldminers - dust, smoking and chronic obstructive pulmonary disease. S Afr Med J. 1992; **81**:512-517.

34. De Kock MA, Swiegers WRS, Kotze TJ, Joubert G. Cross-sectional Study of Uranium MineWorkers to Develop Predictive Equations for Lung Functions With Reference To Chronic Obstructive Pulmonary Disease. S Afr. Med J 1988; **19**(1): 1-20.

35. Murray R. Man and His Work. In: Raffle P A B, Lee. W R, McCullum R I, Murray, R. eds. Hunters Diseases Of Occupation. 6th ed. London. Hodder and Stoughton: 1987; 1-61.

36. Greenberg M, Selikoff IJ. Lung Cancer in the Schneeberg Mines: A Reappraisal of the Data Reported by Hartung and Hesse in 1879. Ann. Occup Hyg, 1993; **37**(1): 5-14.

37. Arnstein A. (1913) on the so-called "Schneeberg Lung Cancer". Verh. dt. path.Ges. **16**, 332-342 (NIH library translation NIH-90-59).

38. Harting FH, Hesse W. (1879) Lung Cancer, the Disease of Miners in the Schneeberg Mines. Vjschr. gericht. Med. off. Sanit. Part I.30, 296-309 (NIH library translation NIH-77-262C); Part 2, 31, 102-129 (NIH library

translation NIH-77-247C); Part 3, **31**,313-337 (NIH library translation NIH-77-246C).

39. Hesse W. (1878) The Occurrence of Primary Lung Cancer in the Miners of the Consortium Mines in Schneeberg. Arch. Heild. **19**, 160-162 (NIH library translation NIH-90-394).

40. Uhlig M. ((1921) Schneeberg Lung Cancer. Virchows Archo. Pathol. Physiol. Ant.**230**, 76-98 (NIH library translation NIH-90-58).

41. Schüttman W. Acknowledgement of Schneeberg Lung Disease as an Occupational Disease in the First Occupational Disease, Z Gesamte Hyg, 1987; **33**(12): 662-665.

42. Schüttman W. Schneeberg Lung Disease and Uranium Mining in the Saxon Ore mountains. Am. J. of Ind. Med., 1993; **23: 355**-368.

43. Craven SH. George Agricola.1494-1555.Mining Engineer and Physician. S Afr Med J .1997**; 87**(5): 611-612.

44. Paracelsus (von Hohenheim, T). Four Treatises Including: On the Miners' Sickness and Other Miners' Diseases. Sigerist, H. ed. Baltimore . John Hopkins Press.1942;

45. Sakula A. Ramazzini's "De Morbis Artificum" and Occupational Lung Disease. Br. J. Dis Chest, 1983: 349-361.

46. Hueper WC. Occupational Tumors and Allied Diseases. Charles C Thomas, Springfield, Illinois.1942;

47. Saccomanno G, Yale C, Dixon W, Auerback O, Huth GC. An Epidemiological Analysis of the Relationship between Exposure to Rn Progeny, Smoking and Bronchogenic Carcinoma in the Uranium Mining Population of the Colorado Plateau - 1960 to 1980. Health Phys. 1986; **50** (5): 605-18.

48. Archer VE. Enhancement of Lung Cancer by Cigarette Smoking in Uranium and Other Miners. Carcinog Compr Surv 1985**; 8:** 23-37.

49. Samet JM, Pathak DR, Morgan MV, Marbury MC, Key CR, Valdivia AA. Radon Progeny Exposure and Lung Cancer Risk in New Mexico Uranium Miners: A Case-Control Study. Health Phys 1989; **56**(4): 415-21.

50. Howe GR, Nair RC, Newcombe HB, Miller AB, Burch JD, Abbatt JD. Lung Cancer Mortality (1950 - 1980) In Relation To Radon Daughter Exposure in A Cohort of Workers at the Eldorado Port Radium Uranium Mine:

Possible Modification of Risk by Exposure Rate. J Natl Cancer Inst 1987; **79**(6): 1255-1260.

51. Howe GR, Nair RC, Newcombe HB, Miller AC, Abbatt JD. Lung Cancer Mortality (1950 - 1980) In Relation To Radon Daughter Exposure in A Cohort of Workers at the Eldorado Beaverlodge Uranium Mine. J Natl Cancer Inst 1986; **77**(2): 357-362.

52. Whittemore AS, McMillan A. Lung Cancer Mortality among U.S. Uranium Miners: A Reappraisal. J Natl Cancer Inst 1983; **71**(3): 489-499.

53. Archer, VE. Enhancement Of Lung Cancer by Cigarette Smoking In Uranium And Other Miners. Carcinog Compr Surv, 1985; **8**: 23-37.

54. Saccomanno G, Huth GC, Auerback O, Kuschner M. Relationship of Radioactive Radon Daughters and Cigarette Smoking in the Genesis of Lung Cancer in Uranium Miners. Cancer, 1988; **62**(7): 1402-1408.

55. Freeman GM, Vernon PN. Technical And Human Considerations In The Development Of The Rössing Uranium Mine. Council of Mining and Metallurgy Inst. 13th Congress, Singapore, 1983;

56. Encyclopedia Britannica. Uranium. 1970; **22**: 778-783.

57. Weast R. Handbook of Chemistry and Physics. 49th ed. The Chemical Rubber Company.1974; 143.

58. Hawley GG. The Condensed Chemical Dictionary 10th ed. 1977; 1071.

59. Charles D. In The Beginning Was Uranium. New Scientist, 1992; **8**: 30-36.

60. Technical publication: Africa Produces A Fifth of the World's Uranium Production. Rössing News 1995**; 6:**5-6.

61. Finkenstein MM. Clinical measures, smoking, radon exposure, and risk of lungcancer in uranium miners. J Occup Environ Med. 1996; **53**: 697-702.

62. Basson JR. Swiegers WRS. Radiation hazards in perspective. S Afr J Occup Health.1999; **5**(2); 40-46.

63. Durrance E. Radon: An Unobtrusive Geological Hazard. British Geologist **13**(2): 72-77.

64. Bowie C, Bowie S. Radon and health. Lancet, 1991; **337**: 409-413.

65. Strydom K. Characteristics and Measurements of Radon. Seminar on Radon Exposure in South Africa. Pelindaba 1987; 10-20.

66. van As D. Health Effects of Radon. Seminar on Radon Exposure in South Africa. Pelindaba. 1987, 10-20.

67. Faleng CT *et al.* Radon in Homes: A Possible Cause of Lung Cancer. Scand J Work Environ Health, 1984; **10**: 25-34.

68. I.C.R.P. Recommendations of the International Commission on Radiological Protection. I.C.R.P. Publication 60 & 65. Annals of the I.C.R.P (1990&1994)

69. Ginevan ME, Mills, WA. Assessing the Risks of Radon Exposure: The Influence of Cigarette Smoking. Health Phys 1986; **51**(2): 163-174.

70. South African Forum for Radiation Protection Publication 9: The Implication of A Survey of Indoor Radon Exposure in South Africa. J of Comp. Health **6**(3) 148-150.

71. Samet JN. Diseases of Uranium Miners and Other Underground Miners Exposed to Radon. In: Rom. W.N. ed. Environmental and Occupational Medicine.2nd ed. Boston. Little, Brown & Company.1992; 1085-1091.

72. Watson GM. The Effects of Ionising Radiation on Man. Atomic Energy, 1975; **10**: 1-11.

73. Wasserman HJ. Quantifying the risks of radiation exposure. S Afr Med J.1986; **20**: 333-336

74. Steward, AM. Evaluation of Delayed Effects of Ionising Radiation. Br J Id Med. 1991; **20**: 805-810.

75. Upton A. The Past Hundred Years of Radiation Research: What They Taught Us. Environmental Research. 1992; **20**; 805-810.

76. McKween JW *et al.* Creating Consensus on Low Level Radiation issues. J. Occup Health Safety (Aust - NZ), 1990; **5**(6): 491- 501.

77. Shulman S. Cancer around Nuclear Plants. Nature, 1990; **347**: 604.

78. Southon FC *et al.* Radiation Risks. Nature, 1991; **349**: 450.

79. Gardner MJ. Fathers Occupational Exposure to Radiation and The Raised Level of Childhood Leukemia near Sellafield Nuclear Plants. Environmental Health Perspectives, 1991; **94**: 5-7.

80. Voelz GL. A Collection of Helpfull Items for Medical Evaluation of Ionizing Radiation Exposure Cares, Los Alamos National Laboratory, Loa Alamos, New Mexico 87545. LA-UR-82-1659.

81. Windell B. Historical Development and Biological Basis of the I.C.R.P Recommendations. SAAP MB Summer School 1992.

82. Sorahan T, Roberts PJ. Childhood Cancer and Potential Exposure to Ionizing Radiation. Preliminary Findings from the Oxford Survey of Childhood Cancers. Am. J. of Ind. Med., 1993; **23**: 343-354.

83. Cehn JI. Reported Cancer Clusters and Nuclear Facilities: What Connection? I.A.E.A Bulletin, 1991; **2**: 28-31.

84. Mukherjee R, Mircheva J. Radiological Effects Of low-level Radiation and Cancer Risks. I.A.E.A Bulletin, 1991; **2**: 32-35.

85. Kneale GW, Steward AM. Factors Affecting Recognition of Cancer Risks On Nuclear Workers.J Occup Environ Med. 1995; **52**: 515-523.

86. Stewart AM, Kneale GW. Relations between age at occupational exposure to ionising radiation and cancer risk. J Occup Environ Med. 1996; **53**: 225-230

87. Wohl ME. Pediatric Origins of Adult Lung Disease. 13th South African Pulmonology Society Congress George. 1996; Apr.

88. Petersen, M. Ciliary Activity and Pollution. Lung 1990; Supp; 368-376.

89. Denison DM. Physiological Principles.In: . Parkes WR ed Occupational Lung Disorders. 3rd ed. New York. Butterworths /Heinemann . 1994; 18-27.

90. Abraham JL. Environmental Pathology of the Lung. In: Parkes WR ed. Occupational Lung Disorders. 3rd ed New York. Butterworths /Heinemann. 1994; 1227-252.

91. Kennedy SW. When is a disease Occupational. Lancet 1994; 344 (2): 4-5.

92. Becklake MR. Occupational Exposures And Chronic Airways Disease.In: Parkes WR ed Occupational Lung Disorders. 3rd ed. New York. Butterworths /Heinemann . 1994; 1227-252.

93. Weinberger E. Recent Advances in Pulmonary Medicine. New Eng. J Med. 1993; **328**(W019): 1389-1396.

94. Crapo J, Miller FJ, Mossman B, Pryor W, Kiley JP. Environmental Lung Disease. Am. Rev Respir Dis 1992; **148**: 1502-1506.

95. Jones DJ. Prescribed Respiratory Diseases in The 1990's. J Resp Med. 1992; **86**, 283-287.

96. Samet JM. Environmental Controls and Lung Diseases. Am Rev : Respiratory Diseases, 1990; **142** : 915-939.

97. Davis JCA. Occupational Lung Diseases (Letter To the Editor). S Afr Med J. 1993; **8**: 64.

98. Devalia JL; Ruznak C; Davies RJ (Ed). Air pollution in the 1990's - Cause of increased respiratory disease? J Respir Med. 1994; **88**. 241 - 244.

99. Terblanche APS. Urban Air Pollution and Community Health. S Afr J Comp Health. 1991; **2** (2): 81-84.

100. Terblanche APS, Uys L, Smit He. The Vaal Triangle Air Pollution Health Study : Study Design. The Southern African J Epi Inf 1991; **6** (2): 23-25.

101. Coetzee M. Smith FCA, v.d. Merwe CA. Dreyer RJ. Die Invloed Van Lugbesoedeling Op Die Gesondheid Van Die Sasolburg-Gebied. S Afr Med J. 1986; **70**: 339-343.

102. Terblanche APS. Personal Monitoring of Air Pollution: How, What, Where?. Clean Air J. 1991; **8:35.**

103. Ras GJ, Iturralde GMP. Verdedigings Meganismes Van Die Long. S Afr J Cont Med Educ. 1986; **4**: 13- 20

104. Haslam PC. Basic Immunology and Immuno Pathology. Occupational Lung Disorders: In: Rom W H ed Environmental and Occupational Medicine. 2nd ed. Boston. Little,Brown&Company. 1992; 50-99.

105. Bohning DE, Lippmann D. Particle Deposition and Pulmonary Defense Mechanisms. In:. Rom W H ed Environmental and Occupational Medicine. 2nd ed. Boston. Little, Brown&Company. 1992, 171-183.

106. Morgan WKC. The Respiratory Effects of Particles, Vapours and Fumes. Am Ind Hyg Assoc J. 1986; **47** (11): 620 - 673.

107. Bowden DH. Macrophages, Dust and Pulmonary Diseases. Experimental Lung Research. 1987; **12**: 89 - 107.

108. Rom WH. Relationship of Inflammatory Cell Cytokines to Disease Severity in individuals with Occupational Inorganic Dust Exposure. Am J Ind Med., 1991: **8**:15-27.

109. Shaw RJ. The role of lung macrophages at the interface between chronic inflammation and fibrosis. J Respir Med. 1991; **85**: 267-273.

110. Brigham KC. Role of Free Radicals in Lung Injury. Chest. 1986; **89**: 859-863.

111. Doelman CJA, BAST A. Oxygen Radicals in Lung Pathology. Free Rad Biol Med 1990; 9 (5): 381-400.

112. Anderson R. The Activated Neutrophil - Formidable Forces Unleashed. S Afr Med J. 1995; **85** (10): 124-128.

113. Maier KL. How the lung deals with oxidants. Eur Respir J, 1993; **6**: 334-336.

114. Cross *et al.* Oxygen Radicals and Human Disease. Ann. Int. Med. 1987; **107**: 526-545.

115. Chandra P. The Pathogenesis of Atopic Disease and The Regulation of IGE Synthesis. ALLSA - I.A.A.C.I International Congress Johannesburg. 1994, Oct. Current Allergy and Clinical Immunology. 1994; **7** (4): 26.

116. Bardin PG, Johnston LS, Hallgate ST. Anti-inflammatory Strategies for the treatment of asthma. S Afr Med J. 1992; 81(21): 303-309.

117. Holgate S. Airway Inflammation in Asthma. S Afr Current Allergy Clin Immunol. 1994; **7**(4): 27 - 80.

118. Ress SR. Clinical Evaluation of Cellular Immune Functions. S Afr Current Allergy Clin Immunol 1994; **7** (4): 26-28.

119. Puterman AS. Cytokines and The Allergic Response - A Basic Introduction. S Afr Current Allergy Clin Immunol. 1995; **8** (1): 14-15.

120. Broide DH. Cytokines and Adhesion Molecules: Implications for the Pathogenesis OF Asthma. S Afr Current Allergy Clinl Immunol. 1995; **8** (1): 19-22.

121. Lee T. Properties and Characteristics of Inflammatory and Resident Cells in Asthmatic Airways. S Afr Current Allergy. Clin Immunology. 1994; **7** (3) 4-6.

122. Cookson B, Ten Kate LP. The Search for Atopy Genes. I.C.A.C.I - E.A.A.C.I. Congress, Stockholm. 1994, Oct.

123. Luyt B, Green R. Prevalence of Asthma in South African Children, A Review. S Afr Current Allergy Clin Immunol. 1994; **7** (2): 4-6.

124. Warner JO, Warner JA. Early Life Origins Of Asthma And Related Allergic Disorders. S Afr Current Allergy Clin Immunol. 1996; **9** (1): 10-15.

125. Jooma OF. Pollution and Asthma.S Afr Current Allergy Clinl Immunol. 1995, **8** (5): 19-20.

126. Holgate S. The Genetic of Asthma and Atopy. S Afr Current Allergy Clinl Immunol. 1996; **9** (1): 3-9.

127. Holgate S. Asthma: Yesterday, Today and Tomorrow - A Personal Journey. 13th Pulmunology Society Congress Geaorge, 1996, Apr.

128. Slovak AJM. Balance of opinion. Should atopic employees be excluded from specific occupations? Occup Med. 1993; **43**: 51-52.

129. Nicholson N. Eosinophilia. N Engl Med 1984; **310**: 1621-1626.

130. Samter M. Eosinophils - nominated but not elected. N Eng. J Med. 1980; **303** (20): 1175-6.

131. Schatz M, Wasserman S, Patterson R. The eosinophil and the lung. Arch Intern Med 1982; **142**: 1515-1519.

132. Burrows B, Hassan FM, Barbee RA, Halonen M, Lebowitz M. Epidemiological observations on eosinophilia and its relation to respiratory disorders. Am Rev Dis 1980; **122**: 709-19.

133. Kauffmann F, Annesi I, Oryszczyn MP. The Relationship between Allergy and Smoking. In: Sluiter HJ, van der Lende R, eds. Bronchitis IV. Assen: Royal van Gorcum, 1989; 57-70.

134. Kauffmann F, Neukirch F, Korobaeff M, Marne MJ, Claude JR, Lellouch J. Eosinophils, Smoking and lung function. An epidemiological survey among 912 working men. Am. Rev. Respr. Dis. 1986; **134**: 1172-1175.

135. Frette C, Annesi I, Korobaeff M, Neukirch F, Dore MF, Kauffmann F. Blood Eosinophilia and FEV_1. Cross-sectional and Longitudinal Analyses. Am Rev. Respir Dis 1991; **143**: 987-992.

136. Annesi I, Oryszczyn M, Frette C, Neukirch F, Orvoen-Frija E, Kauffmann F. Total circulating IgE and FEV_1 in Adult Men. An epidemiological longitudinal study. Chest 1992; **101**: 642-48.

137. Annesi I, Neukirch F, Orvoen-Frija E, *et al.* The relevance of hyperresponsiveness but not of atopy to FEV_1 decline: preliminary results in a working population. Bull Eur Physiopathol Respir 1987; **23**: 397-400.

138. Annesi I, Kauffmann F, Oryszcyn M P, Neukirch F, Orvoen-Frija E, Lellouch J. Leukocyte count and bronchial hyperreseponsiveness. A Allergy Clin Immunol 1988; **82**: 1006-11.

139. Halliwell B. Free Radicals, Anti oxidants and Human Diseases: Curiosity, Cause or Consequent. Lancet. 1994; **344;** 721-724.

140. Theron AJ. Die beskerming van die funksionele aktiwiteit van menslike alpha-1-protease inhibeerder teen fagosiet-bemiddelde oksidatiewe inaktiverings en die toepassing daarvan in sigaretrokers. Pretoria: University of Pretoria, 1986; (doctoral thesis).

141. Green RJ. Alpha-1-Protease Inhibitor in Health and Disease. S Afr Respir J. 1995; **1**(3): 12-16.

142. Hitzeroth HW, Bissbort S, van den Berg CT, van Niekerk MM; de Villiers LS, Niehaus CE, Op't Hof J. Die Alfa-1-Antitripsien Polimorfisme As 'N Egogenetiese Merker: Genetiese Siftingstoetse As 'n Voorkomende Medies-Genetiese Diens. Geneeskunde 1986; **28**: 62-68..

143. Hackey A. What Is A Cigarette. S Afr J Cont Med Educ .1993; **11**(5): 825-830.

144. Wilcox PA. Smoking and the Lung. S Afr J Cont Med Educ .1993; **11**(5): 837-844.

145 Elmes PC. Relative Importance of Cigarette Smoking in Occupational Lung Disease. Br F Ind Med 1981; **38**: 1-13.

146. Hnizdo E, Sluis-Cremer GK, Baskind E *et al.* Emphysema and Airway Obstruction in Non-Smoking South African Gold Miners with Long Exposure to Silica Dust. Occup Environ Med. 1994; **51**: 557-563.

147. Swiegers WRS, Taylor CA. Anti-smoking Campaigns in the Workplace: Rational, Implementation and Effectiveness. S Afr Comp Health. 1992; **1**(6). 16-21.

148. Sheppard D. Significance of Hyperresponsiveness to Occupational and Environmental Lung Disorders. Sem in Resp Med . 1986; 7 (3).

149. Paoletti P, Viegi G, Carrozzi L. Bronchial Hyperreponsiveness, Genetic Predisposition and Environmental Factors: The Importance of Epidemiological Research. Eur Respir J, 1992; **5**: 910-912.

150. Venables K, Bernard M, Graneck J, Taylor A. Bronchial Responsiveness and Reproducibility of forced Expiratory Volume in One Second. Scand J Work. Environmental Health 1993,**19**: 342-345.

151. Brooks SM, Weiss MA, Bernstein IL. Reactive Airways Dysfunction Syndrome. J Occup Med. 1985; **27** (7): 473-476.

152. Tarlo S, Broder I. Irritant-induced Occupational Asthma. Chest. 1989; **96**: 297-300.

153. McFadden ER, Gilbert IA. Asthma. N Eng. J Med. 1992; **327**(27): 1928-1937.

154. Ker JA. Aspects of Asthma. S A Fam. Prac. 1994; 315-318.

155. Chaauhan A, Holgate ST. Treatment and Prevention in Asthma - New Concepts. S Afr J Cont Med Educ. 1996; **14**(4) 485-497.

156. Van Schalkwyk EM. Hands-on Occupational Asthma. S Afr J Cont Med Educ. 1996; **14**(4): 471-482.

157. Gibbald B, Genetic Basis for Asthma. Sem Respir Med. 1986; **7** (4): 307-313.

158. Ehrlich R. Occupational Asthma in South Africa. J Current Allergy Clin Immunol. 1993; **6**(4): 19-21.

159. Chan-Yeung M. Occupational Asthma. Chest. 1990; **98**. 148-161.

160. Smith D. Medical-Legal Definition of Occupational Asthma. Chest. 1990; **98**. 1007-1011.

161. Cockroft D. Occupational Asthma. Am Allergy. 1990; **65**. 169-176.

162. Cowie RL, Mabena Sk. Asthma in goldminers. S Afr Med J. 1996; **86**(7): 804-807.

163. Balmes J. Surveillance for Occupational Asthma. J Occup Med. 1991; **6:** 101-110.

164. Kipen, HM, Blumer R R, Hutt D. Asthma Experience in an Occupational and Environmental Medicine Clinic. J Occup Med. 1994; **36** (10): 1113-1137.

165. Sanchez-Borges M, De Orozeo A, Arellano S, De Gallego, Avila-Mullian E, Suarez-Chacon R. Preventive Role of Atopy in Lung Cancer. Clin Immunold Immunopath. 1986; **41**: 314-319.

166. Antti-Poika M, Nordman H, Koskenvuo M, Kaprio J, Jalava M. Role of occupational exposure to airway irritants in the development of asthma. In Arch Occup Environ Health 1992; **64**: 195-200.

167. American Thoracic Society. Standards For the Diagnosis And Care Of Patients With Chronic Obstructive Pulmonary Disease. Am J Respir Crit Care Med., 1995; **152**: 77-120.

168. Siafakas NM, Vermiere P, Pride NB, Paoletti P, Howard P, Yernault JC, Decramer M, Higenbottan T, Postma DS, Rees J, on behalf of the Task Force. Optimal Assessment and Management of Chronic Obstructive Pulmonary disease (COPD). Eur. RespirJ, 1995; **8**: 1398-1420.

169. Kesten S, Rebuch A. Management of COPD.Drugs.1989; **38**(1). 161-164.

170. Petty T. Early identification and intervention in COPD. Lung and Respiration. 1993; **10**(3): 2-3.

171. Vermeire P. Growing Consensus In COPD. Editorial. Eur Respir J., 1995; 8: 1250-1251

172. Burge PS. Occupation And Chronic Obstructive Pulmonary Disease (COPD). Eur Respir J., 1994; **7**: 1023-1034.

173. Hogg JC. Macklem PT, Thurlbeck WM. Site and nature of airways obstruction in chronic obstructive lung disease. N Engl. J. Med. 1968. **268**: 1355-1360.

174. Cosio MG, Ghezzo H, Hogg JC *et al.* The relations between structural changes in small airways and pulmonary functions test. N Engl J Med 1969; **298**: 1277-1281.

175. Berend N, Woolcock AL, Marlin GE. Correlation between the function and the structure of the lung in smokers. Am Rev Respir Dis 1979; **119**: 695-705.

176. Nagai A, West WW, Thurlbeck WM. The National Institute of Health Positive-Pressure Breathing Trial: Pathology studies. II Correlation between morphologic findings, clinical findings and evidence of airflow obstruction. Am Rev Respir Dis 1985; **132**: 946-953.

177. Hale KA, Ewing SL, Gosnell BA, Niewoehner DE. Lung disease in long-term smokers with and without chronic airflow obstruction. AM Rev Respir Dis 1984; **130**: 716-721

178. Mitchell RS, Stanford RE, Johnson JM, Silvers GW, Dart G, George MS. The morphological features of the bronchi, bronchioles and alveoli in current airway obstruction: A clinicopathological study. Am Rev Respir Dis 1976; **114**: 127-145.

179. Wright JL, Lawson LM, Pare PD *et al.* The detection of small airways disease. Am Rev Respir Dis 1984; **129**: 989-994

180. Churg A, Wright JL, Wiggs B, Pare PD, Lazar N. Small airway disease and mineral dust exposure: prevalence, structure, and function. Am Rev Respir Dis 1985; **131**: 139-43.

181. Wright JL, Cagle P, Churgk A, Colby T, Myers J. Diseases of Small Airways. Am Rev Respiratory Diseases 1992; **146:** 240-262.

182. Buist AS. Current Status of Small Airways Disease. Chest. 1986; **1**: 100-105.

183. Bouhuys A. Breath, Physiology, Environment and Lung Disease. New York: Grune & Stratton, 1974; 174-204.

184. Oxman, AD, Muir, DCF, Shannon, HS, Stock SR, Hnizdo E, Lange, HJ. Occupational Dust Exposure and Chronic Obstructive Pulmonary Disease: A Systematic Overview of the Evidence. Am Rev Resp Dis. 1993; **148:** 38-48.

185. Brooks SM, Kalica AR. Strategies for elucidating the relationship between occupation exposures and chronic airflow obstruction. Am Rev Respir Dis 1987; **135:** 268-273.

186. Foxman B, Higgins ITT. The effects of occupation and smoking on respiratory disease mortality. Am Rev Respir Dis .1986; **134**: 649-52.

187. Becklake MR. Chronic airflow limitation: its relationship to work in dusty occupations. Chest 1985; **88**; 608-17.

188. Muir DCF, Stock SR, Shannon HS, Oxman AD. Chronic lung disease and occupational dust exposure. Scand J Work Environ Health 1989; **15**:239.

189. Brinkman GL, Coates ED jun. The prevalence of chronic bronchitis in an industrial population. Am Rev Respir Dis 1962; **86**: 47-54.

190. Sandhaus RA. Genetic basis of chronic obstructive pulmonary disease. Seminars in Respiratory Medicine 1986; **7**: 353-356.

191. Lundbäck B, Nyström L, Rosenhall, and Stjernberg N. Obstructive Lung Disease in Northern Sweden: Respiratory Symptoms Assessed in A Postal Survey. Eur. Respir J., 1991; **4**: 257-266.

192. Heenderik D, Kromhout H, Kromhout D, Burema J, Biersteker K. Relations Between Occupation, Smoking, Lung Function, And Incidence And Mortality Of Chronic Non-Spesific Lung Disease: The Zutphen Study. 1992; **49**: 299-308.

193. Post WK. Heenderik D, Kromhout H, Kromhout. Occupational exposure estimated by a population specific matrix and 25 years incidence of CNSLD (Zutphen Study. Eur. Respir. J. 1994; **7**: 1048-1055.

194. Dodge R, Cline MG, and Burrows B. Comparison of Asthma, Emphysema, And Chronic Bronchitis Diagnosis in A General Population Sample. Am Rev Respir Dis, 1986; **133** (6) 981-986

195. Xiping XU, Christiani C, Douglas W, Dockery, Lihua Wang. Exposure-Response Relationships between Occupational Exposures and Chronis Rèspitory Illness: A Community-Based Study. Am Rev Respir Dis, 1992; **146**: 413-418.

196. Viegi *et al.* Respiratory Effects of Occupational Exposure in A General Population Sample in North Italy. Am Rev Respir Dis, 1991; **143**: 510-515.

197. Medical Research Council. Chronic bronchitis and occupation. Br Med J 1966; **I**: 101

198. Le Roy Lapp. Industrial bronchitis. In. Occupational Lung Diseases. : Morgan WK and Seaton A, eds WB Saunders Company, 1975: 265-273.

199. Crapo, J Miller FJ, Mossman B, Pryor WA, Kiley JP. Relationship between Acute Inflammatory Responses to Air Pollutants and Chronic Lung Disease. Am Rev Respir Dis 1992. **145**:1506,1512.

200. Sluis-Cremer GK, Walters LG, Sichel HS. Chronic bronchitis in miners and non-miners; an epidemiological survey of a community in the gold mining community in the gold mining area in Transvaal. Br J Ind Med 1967; **24**: 1-12.

201. Zwi S, Ehrlich R, Rees D, Zwi AB. The Pneumoconiosis. S Afr J Cont Med Educ. 1986; **4**; 93-99.

202. Rosenman KD, Zhu, Z. Pneumoconiosis and associated conditions. American Journal of Industrial Med. 1995; **17:** 107-113.

203. Heppleston AG. Minerals, Fibrosis, and the lung. Env Health Perspectives 1991; **94**; 149-168.

204. Katsnelson BA, Polzik EV, Privalova LI. Some aspects of the problem of individual predisposition to silicosis. Env Health Perspectives. 1986; **68**: 175-185

205. Davis GS. The pathogenesis of silicosis: state of the art. Am Rev Respir Dis. 1976; **63:** 180-182.

206. Davis GS. Pathogenesis of Silicosis: current concepts and hypotheses. Lung .1986; **164**; 139-154.

207. Laurie DB. What goes wrong with the macrophage is silicosis? Eur J Respir Dis. 1982; **63**: 180-182.

208. Bagchi N, What makes silica toxic? Br J of Ind Med 1992; **49**: 163-166.

209. Koskinen H. Symptoms and clinical findings in patients with silicosis. Scand J Work Environ Health 1985; **11**: 101-106.

210. Cowie, RL, Mabena, SK. Silicosis, chronic airflow limitation, and chronic bronchitis in South African gold miners. Am Rev Respir Dis 1991; **143** 80-84.

211. Hnizdo E, Baskind E, Sluis-Cremer GK. Combined effect of silica dust exposure and tobacco smoking on the prevalence of respiratory impairments among gold miners. Scand J Work Environ Health 1990; **16**: 411-22.

212. Hnizdo E. Combined effect of silica dust and tobacco smoking on mortality from chronic obstructive lung disease in gold miners. Br J Ind Med 1990; **47**: 656-64.

213. Hnizdo E, Sluis-Cremer GK, Abramowitz JA. Emphysema type in relation to silica dust exposure in South African gold miners. Am Rev Respir Dis 1991; **143**: 1241-7.

214. Manfreda, Sidwall G, Maini K, West, P Cherniack, RM. Respiratory Abnormalities in Employees of the Hard Rock Mining Industry. Am Rev Respir Dis. 1992; **126** (4) ; 629.

215. Cowie RL, Hay M, Thomas RG. Association of silicosis, lung dysfunction and emphysema in goldminers. Thorax. 1993; **48**: 646-649.

216. Wiles FJ, Baskind E, Hessel PA, Bezuidenhout B, Hnizdo E, Lung functions in Silicosis. Int Arch Occup. Envir. Health. 1992; **63**:387-391.

217. Becklake MR, Irwig L, Kielkowski D, Webster I, De Beer M, Landua S. The predictors of emphysema in South African gold miners. Am. Rev. Respir. Dis.1978; **135**:1234-1241.

218. Soutar CA, Hurley, JF. Relations between dust exposure and lung function in miners and ex-miners. Br J Ind Med 1986; **43**: 307-320.

219. Hnizdo E. Loss of lung function associated with exposure to silica dust and with smoking and its relation to disability and mortality in South African gold miners. Br J Ind Med 1992; **49**:472-479.

220. Reger RB, Morgan, WK. Silica : is it a carcinogen? J Occup Health Safety - Aust NZ 1990; **6**; 481-490.

221. Agius R, Is silica carcinogenic. Occup Med. 1992, 42; 50-52.

222. Pairon JC, Brochard, P Jaurand MC, Bignon J. Silica and lung cancer : a controversial issue. Eur Respir J. 1991; **4**: 730-744.

223. Hnizdo E, Sluis-Cremer GK. Silica exposure, silicosis, and lung cancer: A mortality study of South African gold miners. Br J Ind Med. 1991; **48**; 53-60.

224. Hesse P A, Sluis-Cremer GK, Hnizdo, E. Silica Exposure, Silicosis and Lung Cancer: A Necropsy Study. Br J Ind Med.1990; **7:** 4-9.

225. Balmes J. Silica Exposure and Tuberculosis: An Old Problem with Some New Twists. J Occup Med. 1990; **32**(2): 114-115

226. Cowie RL. The Epidemiology of Tuberculosis in Gold Miners with Silicosis. Am J Respir Crit Care Med. 1994; **150**: 1460-1462

227. Cowie RL. Diagnosis and Treatment of Tuberculosis. S Afr J Cont Med Educ. 1986. **4**: 59-63.

228. Wilkinson, David Tuberculosis control in South Africa - Time for a new paradigm. S Afr J Med. 1996; **86**(1): 33-35

229. Gilpin T.P., Hammond M Active case finding - for the whole community or for tuberculosis contacts only? . S Far J Med. 1987; **72**: 260-262

230. Sheraton D, Landau F. Morbidity of pulmonary tuberculosis among silicotic and non-silicotic foundry workers in Denmark. J Occup Med. 1990; **32**: 110-113

231. Snider DE, The relationship between tuberculosis and silicosis. Am Rev Respir Dis. 1978; **118**: 455-460.

232. Cowie RL, Langton M, Becklake MR. Pulmonary tuberculosis in South African gold miners. Am Rev Respir Dis. 1989; **139:** 1086- 1089.

233. Bruce T. Silicotuberculosis. Scand J Respir Dis. 1968; **65:** 139-146.

234. Westerholm P, Ahlmark A, Maasing R *et al*, Sillicosis and risk of lung cancer or lung tuberculosis: a cohort study. Environ Res. 1986; **41**; 339-390.

235. Picado C, Roisin RR, Sala H, Agusti-Vidal, A. Diagnosis of Asbestosis. 1984; **162**; 325-335.

236. Webster I. Asbestos related diseases. S Afr J Cont Med Educ. 1986; **4**(4) 71-77.

237. Lerman L, Seidman H, Gelb S, Miller A, Selikoff IJ. Spirometric Abnormalities among asbestos insulation workers. J Occup Med.1988; **30 (** 2): 229-234.

238. Harber P, Mohsenifar Z, Oren A, Lew M. Pleural plaques and asbestos-associated malignancy. J Occup Med.1987; **29**(8): 641-643

239. Bohlig, H Calaverzos, A. Development, radiological zone patterns, and importance of diffuse pleural thickening in relation to occupational exposure to asbestos. Br J Ind Med 1987; **44**; 673-681.

240. Bohlig H, Calverezos A. Development, radiological zone patterns, and importance of diffuse pleural thickening in relation to occupational exposure to asbestos. Br J Ind Med. 1987; **44**; 673-681.

241. Kiburn KH, Warshaw R. Pulmonary Functional impairment Associated with Pleural Asbestos Disease: Circumscribed and Diffuse Thickening. Chest 1990; **94**(4); 965-972.

242. Harrington JM, Levy LS. Lung Cancer. In: Parkes WR ed. Occupational Lung Disorders. 3rd ed. New York. Butterworths /Heinemann . 1994; 644-669.

243. Girdwood RW, Wessels A. A practical approach to carcinoma of the lung. Understanding Oncology.1995; **6**(1): 11-15.

244. Yach D. The incidence and determinants of Lung Cancer. Understanding Oncology.1995; **6**(1): 4-11.

245. Davila DG, Williams DE. The etiology of lung cancer. Mayo Clin. Prac.1993; **68**: 170-182.

246. Shields PG. Inherited Factors and Environmental Exposures in Cancer Risk. J Occup Med.1993; **35** (1) : 34-39.

247. Iannuzzi MC, Muller YE. Genetic prediposion to lung cancer. Seminars in Respir. Med. 1986; **7**(4): 327-332.

248. Terstein A. Advances in Lung Cancer? Environmental Research. 1992; **59**: 145-149.

249. Austoker J. Cancer prevention in primary care- current trends and some prospects for the future. Br Med J. 1995; **3**: 196-199.

250. Bateman ED. The challenge of lung cancer in South Africa. Understanding Oncology. 1995; **6**(1): 1.

251. Mcglashan ND. Harington JS. Lung cancer 1978-1981 in black peoples of South Africa. 1985; **52**(3): 339-346.

252. Kipen HM. Wartenberg D. Scully F. *et al*. Are Non-Whites at Greater Risk for Occupational Cancer? Am J Ind Med. 1991; I9: 67-74.

253. Doll R, Peto R, Wheatly K, Fray R, Sutherland I, Mortality in relation to smoking: 40 years observation in male British doctors. Br Med J. 1994; **303**: 901-911.

254. Respiratory Health Effects of Passive Smoking, Lung Cancer and Other Disorders. Office of Health and Environmental Assessment. EPA (USA): 600-6.90-006F.

255. Clemmesen J. Lung cancer from smoking: Delays and attitude 1912-1965, Am J of Ind. Med. 1993; **23**: 941-953.

256. Morabia A, Markowitz S, Garibaldi K, Wynder EL. Lung Cancer and Occupation: Results of a Multicentre Case - Control Study. Br Ed J 1992; 49: 721-727.

257. I.A.R.C. Study Group. Cancer Risk Among Nuclear Industry Workers. Lancet. 1994; **344:** 1039-1043.

258. Halpern J, Whittemore AS. Methods for analyzing occupational cohort data with application to lung cancer in U.S. uranium miners. J Chronic Dis 1987; **40** (2): 78-88.

259. Roscoe RJ, Steenland K, Halperin WE, Beaumont JJ, Waxweiler RJ. Lung cancer mortality among non-smoking uranium miners exposed to radon daughters. JAMA 1989; **265**(5): 629-633.

260. Samet JM, Pathak DR, Morgan MV, Marbury MC, Key CR, Valdiva AA. Radon progeny exposure and lung cancer risk in New Mexico uranium miners: a case-control study. Health Phys 1989; **56**(4): 415-421

261. De Kock MA. Long funksies in die praktyk. S Afr J Cont Med Educ .1986; **4**: 31-42.

262. De Kock MA, Swiegers WRS, Wright R. The Flow volume curve as a mass screening test with emphasis on quality control. S Afr Med J 1989; **75**: 261-270.

263. Gibson GJ. Standardised lung function testing. Eur Respir J.1993; **6**: 155-157.

264. White N, Erlich RI, Rees D. A guide to spirometry as applied to occupational health. S Afr Med J. 1996; **86**(7): 807-813.

265. Miller AM. Spirometry and maximum expiratory flow-volume curves. In: Miller A, ed. Pulmonary Function Tests in Clinical and Occupation Lung Disease. New York: Grune & Stratton, 1986: 15-51.

266. American Thoracic Society. ATS Statement - Snowbird Workshop on standardisation of spirometry. Am Rev Respir Dis, 1979**; 119**: 831-838.

267. American Thoracic Society. Standardisation of Spirometry - 1987 Update. Am Rev Respir Dis, 1987; **136:** 1285-1298.

268. ATS.Lungfunction testing.Selection of reference values and interpretation strategies. Official statement of the American Thoracic Society.Am Rev Respir Dis. 1991; **188**: 1208-1218.

269. Stewart RI. Basson E. Standardisation of spirometry. S Afr Med J. 1991; 79: 401404.

270. European Respiratory Society Official Statement. Standarized Lung Function Testing: Lung volumes and ventilatory flows, 1993 Update;Report Working Party, Standardization of Lung Function Tests. Eur Respir J .1993; 6: Suppl 16. 5-40.

271. British Thoracic Society. Guidelines for the measurement of respiratory function. Respir. Med.1994; **88:165**-194.

272. American Thoracic Society. Standardisation of Spirometry, 1994 Update. Am J Respir Crit Care Med.1995; **152**: 1107-1136.

273. Mohler JG. Measurement: Theory and practice. In: Clausen JL, ed Pulmonary Function Testing: Guidelines and Controversies, New York: Academic Press 1982; 23-26.

274. Bushey HA Jun, Dawson A. Spirometry and flow-volume curves. In: Clausen JL, ed Pulmonary Function Testing: Guidelines and Controversies. London: Academic Press, 1982; 61-80.

275. Buist AS. Evaluation of lung function: tests of small airway function. Current Pulmonology. New York: John Wiley & Sons, 1981: **3**: 341-358.

276. Berend N. Tests of small airway function. Seminars in Respiratory Medicine 1983; **4**: 214-221.

277. Gelb AF, Zamel N. Simplified diagnosis of small airway obstruction. N Eng. J Med 1973; **288:** 395-398.

278. Buist AS, Ross BB. Quantitative analyses of the alveolar plateau in the diagnosis of early airway obstruction. Am Rev Respir Dis 1973; 108: 1078-1087.

279. Buist AS, Ross BB. Predicted values for closing volumes using a modified single breath nitrogen test. Am Rev Respir Dis 1973; **107**: 744-748.

280. McCarthy DS, Spencer R, Greene R, Milic-Emili J. Measurement of 'closing volume' as a simple and sensitive test for early detection of small airway disease. Am J Med 1972; **52**: 747-753,

281. McCarthy D, Craig DB, Cherniak RM. Intra-individual variability in maximal expiratory flow-volume and closing volume in asymptotic subjects: Am Rev Respir Dis 1975; **112**: 407-411.

282. Woolcock AJ, Vincent NJ, Macklem PT. Frequency dependence of compliance as a test for obstruction in the small airways. J Clin Invest 1969; **48**: 1097-1106.

283. Ingram RM Jun, O'Cain CF. Frequency dependence of compliance in apparently healthy smokers versus non-smokers. Bull Physio-Path Resp 1971; **7:** 195-210.

284. Dosman J, Bode F, Urbanetti J, Martin R, Macklem PT. The use of a helium oxygen mixture during maximum expiratory flow to demonstrate obstruction in small airways in smokers. F Clin Invest 1975**; 55**: 1090-1099.

285. Clausen JL. Prediction of normal values. In: Clausen JL, ed. Pulmonary Function Testing Guidelines and Controversies. London: Academic Press, 1982: 49-58.

286. Norton AC. Accuracy in pulmonary measurements. Respiratory Care, 1979; **24**: 131-137.

287. Buist AS. Evaluation of lung function: concepts of normality. In : Simmons DH, ed. Current Pulmonology. Vol. 4, New York: John Wiley & Sons, 1982: 141-161.

288. Bouhuys A. Beck GJ. Schoenberg JB. Lungfunction: normal values and risk factors. In: Sadoul P, Milic-Emili J, Simonsson BG, Clark TJH, eds. Small Airways in Health and Disease. Proceedings of a Symposium, Copenhagen 1979. Amsterdam: Excerpta Medica, 1979: 196-213.

289. Murray JF. The limitations of pulmonary function testing. In: Wilson AF, ed. Pulmonary Function Testing, Indications and Interpretations. New York: Grune & Stratton, 1985: 1-8.

290. Butler J. The pulmonary function test: cautious overinterpretation. Chest, 1981; **79**: 498-500.

291. Morris JF, Koski A, Johnson LC. Spirometric standards for healthy non-smoking adults. Am Rev Respir Dis 1971; **103**: 57-67.

292. Schoenberg JB, Beck GJ, Bouhuys A. Growth and decay of pulmonary function in healthy blacks and whites. Respir Physiol 1978**: 33**: 367-393..

293. Verdal S, Crap RO. False-positive rate of multiple pulmonary function tests in healthy subjects. Bull Eur Physiopathol Respir 1983: **19**: 263-266.

294. Sobol BJ. Some cautions in the use of routine spirometry. Arch Intern Med 1966; **118:** 335-339.

295. Abramowitz S, Leiner GC, Lewis WA, Small MJ. Vital capacity in the Negro. Am Rev Respir Dis 1965**; 92**: 287-292.

296. Johansen ZM, Erasmus LD. Clinical spirometry in normal Bantu. Am Rev Respir Dis 1968; **97**: 585-595.

297. Mustafia KY. Spirometric lung function tests in normal men of African ethnic origin. Am Rev Respir Dis 1971; **116**: 209-213.

298. Steitzer CC, Siegelaub AB, Friedman GD, Collen MF. Differences in pulmonary function related to smoking habits and race. Am Rev Respir Dis 1974**; 110**: 598-608.

299. Oscherwitz M, Edlavitch SA, Baker TF, Jarboe T. Differences in pulmonary function in various racial groups. Am J Epidemiol 1972; 96: 319-327.67. Stebbings JH. A survey of respiratory disease among New York City postal and transit workers. IV. Racial differences in the FEV_1. Environmental Research 1973; **6:** 147-158.

300. Rossiter CE, Weil H. Ethnic differences in lung function: evidence for proportional differences. Int J Epidemiol .1974; **3**: 55-60.

301. Damon A. Negro-white differences in pulmonary function (vital capacity, timed vital capacity and expiratory flow rate). Hum Biol 1966; **38**: 380-392.

302. Lapp NL, Amandus HE, Hall R, Morgan WKC. Lung volumes and flow rates in Black and White subjects. Thorax, 1974; **29**: 185-188.

303. Lanese RR, Keller MD, Foley MF *et al.* Differences in pulmonary function tests among Whites, Blacks and American Indians in a textile company. Occup Med 1978; **20**: 39-44

304. Corey PN, Ashley MJ, Chan-Yeung MB. Racial differences in lung function: Search for proportional relationships. J Occup Med 1979; **21**: 395-398.

305. Stinson JM, Mc Pherson GL, Hicks K *et al*. Spirometric standards for healthy black adults. J Natl Med Assoc 1981; **73**: 727-733.

306. Myers JE. Differential ethnic standard of lung functions, or one standard for all? S Afr Med J. 1984; **65**: 768-772.

307. Morrison SC, Benator SR. Differential ethnic standards for lung functions. (Correspondence). S Afr Med J 1984; **66**: 833.

308. Myers JD. Differential ethnic standards for lung functions (Correspondence). S Afr Med J 1984; **66**: 833-834.

309. Davies JCA, Becklake MR. Reference values for lung function - more to be done. S Afr Med J 1984; **66**:830.

310. Steinberg M, Becklake MR. Socio-environmental factors and lung function. S Afr Med J 1986; **70**: 270-274.

311. Mokoetle KE; de Beer M; Malekele LL; Steinberg MH, Becklake MR. A Respiratory Health Survey of an urban black workforce in Johannesburg: Determinants of symptoms and of lung function. WITS. MSc Thesis 1990.

312. Hamssain, MH. Pulmonary function in normal nonsmoking black Southern African adults. J Respir Med. 1994**; 88**. 287-291.

313. Louw SJ, Golden JG, Joubert G. Spirometry of Healthy South African Men S Afr Med J. 1996; **86**(7): 814-826.

314. Becklake M. The healthy smoker effect: a phenomenon of health selection. Respiration 1990; **57**: 137-144.

315. Arrighi HM, Hertz-Piccoitto I. Controlling the healthy worker survivor effect: an example of arsenic exposure and respiratory cancer.J Occup Environ Med. 1996; **53**: 455-462

316. Swiegers WRS, Jooste AWJ. Environmental health at Rössing Mine. International Uranium Mining Conference, Swakopmund, 1986.

317. International Labour Office: Guidelines for the use of ILO International Classification of Radiographs of Pneumoconiosis. Rev.1980 Geneva

Switzerland: International Labour Office. Occupational Safety and Health Series No 22 1980.

318. SAS Institute Inc SAS® User's Guide, Version.5th and 6th ed. Cary, NC: SAS Institute Inc. 1985.and 1989.

319. Galpin JS. Regression package REGPAC (Version 3). Special Report. Pretoria: National Research Institute for Mathematical Sciences, CSIR, 1981.

320. Annals of the ICRP publication 30 (2) 3/4

321. Cofield, RE. In vivo gamma counting as a measurement of uranium in the human lung. Health Phys. 1960; **2**: 269-287

322. Bogen J, Fessler H, Petkov T, Scieferdecker H. Setup of an 8-inch sandwich detector for in vivo measurement of transuranium nuclides in the human lung. Kernforschungszentrum Karlsruh. FK 2184 1976;

323. Fry FA, Sumerling JT. The design and construction of a realistic thorax phantom for in vivo measurements of low energy Photon emitters. Phys. Med Biol. 1982; **27**(11): 1367-1379.

324. Van Reenen OR, Lotter MG, Minnaar PC, Itturalde M. Calibration and measurement of potassium-40 with whole body counter. S Afr Med J. 1974; **48**: 2482-2485.

325. Olivier JHI, Wasserman HJ. Report on in vivo measurements of uranium in the chest. Unpublished report 1987.

326. Van Rensburg AJ. Critical look at in vivo determination of workers at Rössing Uranium Limited. Unpublished Report 1991.

327. Kruger PJ, Feather IJ. In vivo measurements in the human chest under high background conditions. ISBNO 869607278. 1980;

328. Keane At. Polednak AP. Retension of uranium in the chest. Implications of findings in vivo and post-mortem. Health Phys. 1993; **44**(1): 391-402.

329. Melamek M, Flehinger B. Screening for lungcancer. Chest. 1984; **86** (1); 2-3.

330. Berlin W, Buncher c, Fontana R, Frost J, Melamed M. The National Cancer Institute Co-operation. Early lung cancer detection program. Am Rev of Respir Dis. 1984 **140** (4); 545-554.

331. Band P, Feldstein M, Watson I, King G; Saccomanno G. Lung cancer screening programs in Canadian uranium mines. Recent Results Cancer Res 1982; **82**: 153-158.

332. Saccomanno G, Archer VE, Auerbach O, Saunders RP; Brennan LM. Development of carcinoma of the lung as reflected in exfoliated cells. Cancer 1974; **33**(1): 256-270.

333. Saccomanno G, Saunders RP, Archer VE, Auerbach O, Kuschner M, Beckler PA. Cancer of the lung: the cytology of sputum prior to the development of carcinoma. Acta Cytol 1965; **9**(6): 413-423.

334. Davis JLA, Landau SP, Goldsmith C. Lung Cancer Cell Types and Lung Exposure. S Afr Med J. 1988; **74:** 607 - 610.

335. Pilotti S, Rilke F, Gribaudi G, Ravasi GL. Sputum Cytology for the diagnosis of Carcinoma of the lung. Acta Cytologica. 1987; **31** (2); 151-164.

336. Gupta RK, Value of Sputum Cytology in the diagnosis of typing of Bronchogenic Carcinomas excluding Adenocarcinomas Acta Cytological .t 1982; **26** (5) 649-653.

337. Risse E, Van't Hof M, Vooijs G. Relationship between patient characteristics and the sputum cytology diagnosis of lung cancer. Acta Cytological. 1987; **31** W02.

338. Melamek M, Flehinger B, ZamanM, Hellan R, Perchick W, Martini W. Early lung cancer detection; Results of the initial (prevalence) radiological and Cytological screening in the Memorial Sloan - Kettering Study. Am Rev Respir Diseases. 1984; **30**(4) 555-560.

339. Pearson FC. Overview "Mayo lung project" of the U.S. National Institute of Health. CAIRS Publication 1986.

340. Fontana K, Sanderson D, Taylor W, Woolner C, Muller W, Muhn J, Uhlenhopp M. Early lung cancer detection: results of the initial (prevalence) radiological and cytological screening in the Mayo Clinic Study. Am Rev of Resp. Dis 1985; **140** (4) 561-570.

341. Benbassat B (Ed). Predictive Value of Sputum Cytology. Thorax 1987: **42;** 165-172.

342. Baldwin F, Hovey A, McEwen T, McEwen T, O'Connor R, Unruh H, Bowden DH. Surface to nuclear distances in human bronchial

epithelium: relationships to penetration by Rn daughters. Health Phys. 1991; **60** (2); 155-62.

343. Loomis DP, Shy CM, Allen JW, Saccomanno G. Micronuclei in epithelial cells from sputum of uranium workers. Scand J Work Environ Health. 1990; **16**(5); 355-62.

344. Hnizdo E, Murray J. Risk of Pulmonary Tuberculosis Relative to Silicosis and Exposure to Silica Dust in South African Gold Miners. Occup Environ Med. 1998; **55**: 496-502.

345. Benatar SR. Sarcoidosis in South Africa. A Comparative study in Whites, Blacks and Coloureds. S Afr Med J .1977; **52**: 602-606.

346. Morar R. Sarcoidosis- a review. South African Respiratory Journal. 1995; **1** (2): 11-16.

347. Rafnsson V. Ingemarsson O.Hjalmarsson I. *et al*. Association between exposure to crystalline silica and risk of sarcoidosis. Occup Environ Med 1998; **55**:657-660

348. Paggiaro PL, Moscato G, Giannini D, Di Franco A, Gherson G. Relationship between peak expiratory flow (PEF) and FEV_1. Eur Respir J. 1997; **10**(24): 29-44.

349. Joubert JR, Swart F, Van Schalkwyk EM Kotze D, Pretorius J. Objective Identification of Risk Factors in mineworkers. SA Pulmonology Society Congress. 1997;. Vol. 14: 56

350. Joubert JR, Van Schalkwyk EM, Pretorius J, De Kock MA, Swiegers W. The Influence of Environmental factors on the Lung Health of Workers at Rössing Uranium Mine. SA Pulmonology Society Congress. 1996; Vol. 13: 8

351. Maree D, Joubert JR, Mouton J, Kotze D, Pretorius J, Swiegers W. Longitudinal Decline of Lung Function in Fume Exposed Workers. SA Pulmonology Society Congress. 1997; Vol. 14: 55

352. Sitas F, Koehler S, Bakainaga C, Pretorius J. Cancer patterns among ex- and current employees of Rössing Uranium Ltd. Namibia. Unpublished article. June 1997.

353. Myers JE. Occupational Epidemiology. In: Katkenellenbogen J, Joubert G, Yach D ed. Introductory Manual for Epidemiology in Southern Africa. Medical Research Council. 1991; 109-112.

APPENDIX A

PAPERS PRESENTED OR PUBLISHED FROM RESEARCH PRESENTED IN THIS THESIS

1. The application of modern methodology to the study of early lung function changes in workers in a uranium mine. MA de Kock, WRS Swiegers, CM Lewis. Poster presentation, International Conference on Occupational Radiation and Safety. Toronto. October 15, 1984.

2. Cross sectional study of uranium mine workers to develop predictive equations for lung functions with reference to chronic obstructive pulmonary disease. MA de Kock, WRS Swiegers, TJvW Kotze, G Joubert. Supplement to the SA Medical Journal. S Afr Med J. 1988; **19** (1): 1-20

3. Flow volume curve as a mass screening test and in epidemiology: emphasis on quality control. MA de Kock, WRS Swiegers, R Wright. S Afr Med J.1988; **75**: 261 -270

APPENDIX B

OVERVIEW OF RÖSSING

B1 HISTORY OF ROSSING

In 1910 Dr E Reuning first recognised the presence of radioactive materials in the Rössing area. He found a heliodore (golden beryl) in a pegmatite near Rössing Mountain which contained radioactive U_3O_8 (0,02-0,04%) (Berning, 1986). In 1921, Dr P A Wagner postulated that the uranium content of the heliodore indicated that the magmatide solution from which the pegmatite crystallised was also radioactive (Wagner, 1921). In 1928, Captain Peter Louw, a part-time prospector from Swakopmund, and his wife Margery measured radioactive levels on a sample of a heavy black mineral (pitchblende) found 20 kilometres from present day Rössing.

In 1932 (Prof TW Gevers) and in 1948 (CM Schwellnus and GSJ Kuschke) confirmed the presence of radioactive minerals but no economic importance was attached to their discoveries.

The Louw family formed a syndicate in 1953, obtained a prospecting grant and set out to relocate the original discovery. In 1954 they succeeded but were unable to arouse local interest. They approached the Anglo-American Corporation and signed a prospecting and option agreement. After extensive exploration and drilling they concluded that although the area contained several million tons of low-grade uranium, the grade was too low and the mineralisation too erratic to warrant economically viable mining.

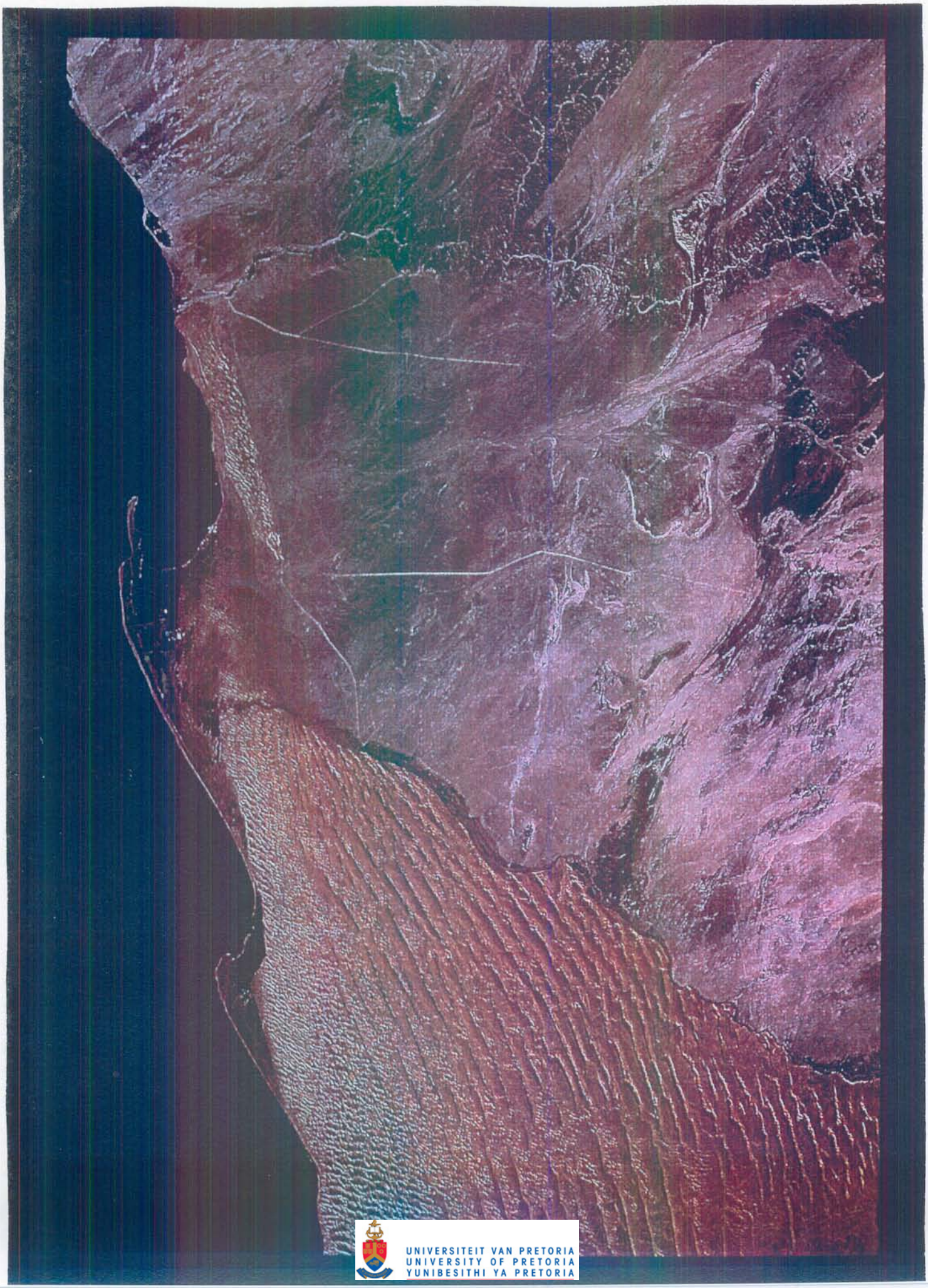
In August 1966, the Rio Tinto Zinc Corporation Ltd (RTZ) acquired the rights to explore this area. Extensive evaluation in a 100 ton per day pilot

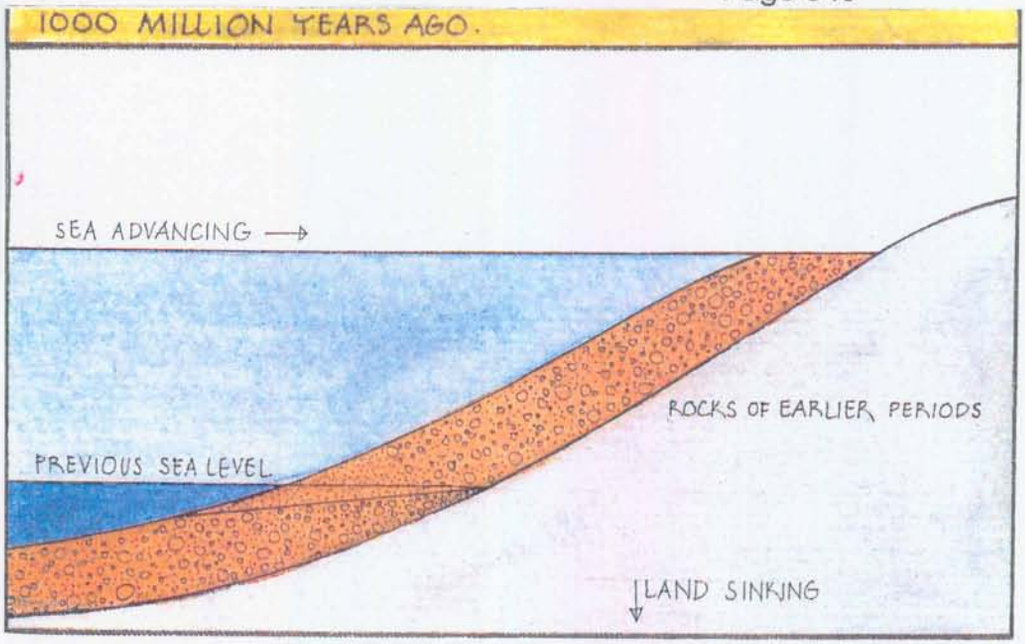
plant confirmed the possibility of establishing a low grade mine, but with a huge deposit and to which the techniques of bulk, low grade open pit mining could be applied. Rössing Uranium Ltd was formed in 1970 and in 1973 the uranium market picked up which enabled commissioning of the mine. The production capacity was set at 5000 annual short tons of oxide.

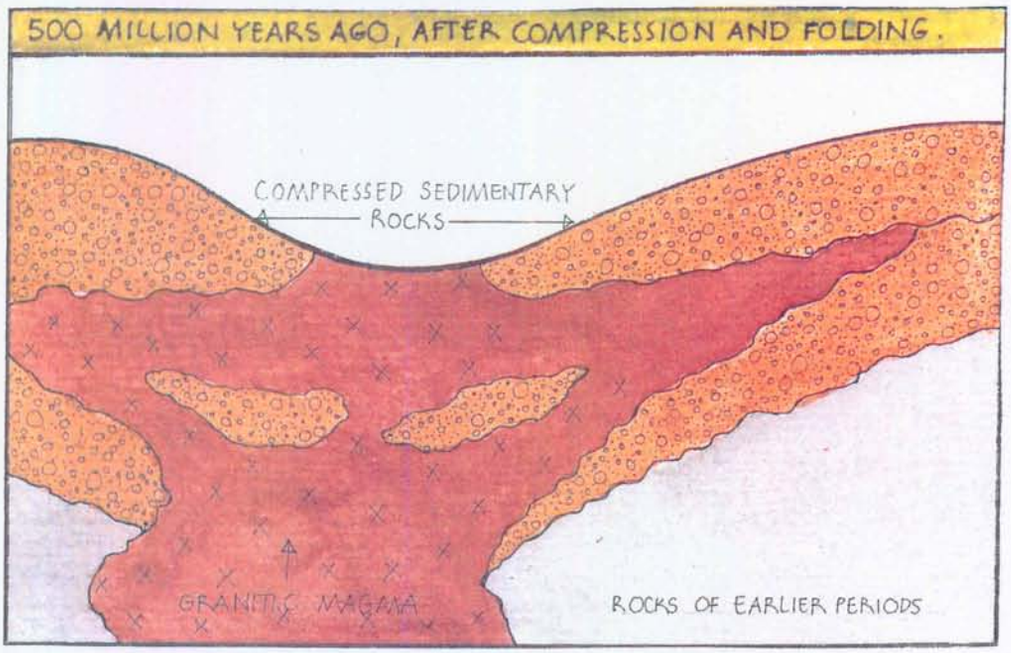
In mid-1974 the first ground in the open pit was broken and the process plant built producing the first yellow cake. The mine's development was rapid, but the granite Alaskite was highly abrasive resulting in excessive breakdown and maintenance problems.

Technical problems with the Rössing start-up necessitated a major modification programme that was implemented in 1978. Unfortunately at midnight on 24 May 1978 a section of the solvent extraction plant burnt down wiping out half the capacity of the biggest uranium solvent extraction plant in the world. However the plant was soon to be operational again.

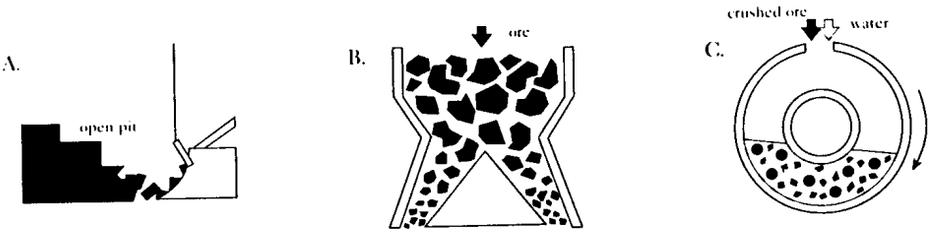
At times the mine produced up to 5 000 short tons of yellow cake for a number of years. The strategic value of uranium diminished (along with an over-supply) when east/west confrontation politics disappeared during the mid and late 1980's and Rössing retrenched more than half of its work force during the 1989 - 1992 period. It is still producing yellow cake but at a much lower scale (2 000 short tons) and is currently operating with a manpower complement of approximately 1 300 employees. It still produces 7,7 per cent of the Western World's production.



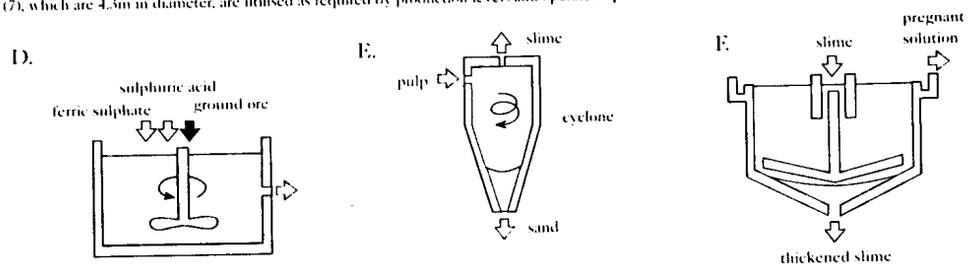




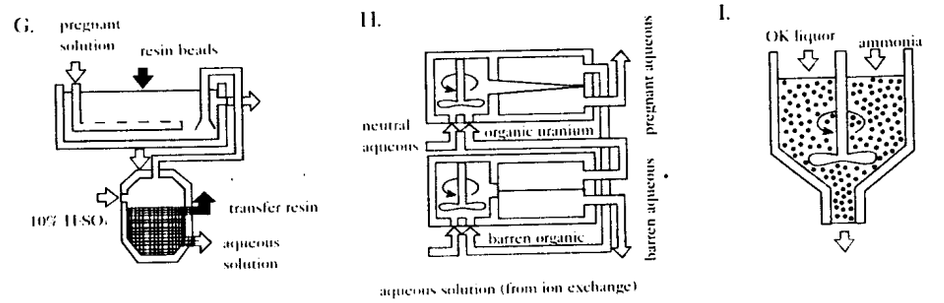
MINING AND METALLURGICAL OPERATIONS



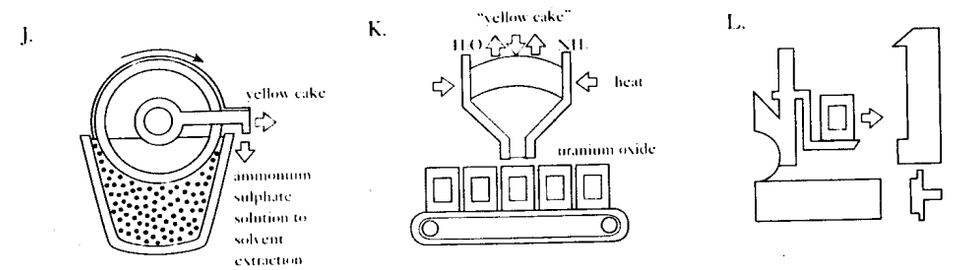
A. MINING: (1) The uranium ore at Rössing is recovered by drilling, blasting, loading and haulage. Due to erratic distribution of minerals in the ground, waste and ore are often mixed together. Radiometric scanners measure the radioactivity level of each truckload (1a). This determines whether the material is sent to the primary crushers (2) or to low-grade stockpile. Waste is transported to a separate dump.
B. CRUSHING: Ore is delivered to the primary crushers (2) by haultruck and then by conveyor to the coarse ore stockpile (3). It passes through a further series of crushers and screens (4) until the particles are smaller than 19mm. After weighing (5) this fine ore is stored on another stockpile (6).
C. GRINDING: Wet grinding of the crushed ore by means of steel rods reduces it further to a slurry with the consistency of mud. The four rodmills (7), which are 4.3m in diameter, are utilised as required by production levels and operate in parallel.



D. LEACHING: A combined leaching and oxidation process takes place in large mechanically agitated tanks (8). The uranium content of the pulped ore is oxidised by ferric sulphate and dissolved in a sulphuric acid solution. Sulphuric acid is produced through a pyrite-roasting process on site (14).
E. SAND/SLIME SEPARATION: The product of leaching is a pulp containing suspended sand and slime. Cyclones separate these components and, after washing in Rotoscoops (9) to remove traces of uranium-bearing solution, the sand is pumped through a pipe (9a) to a tailings disposal area.
F. THICKENING: Counter-current decantation thickeners (10) wash the slimes from previous stages. A clear uranium-bearing solution ('pregnant' solution) overflows from No. 1 thickener, while the washed slime is mixed with the sands and pumped to the tailings area (9a).

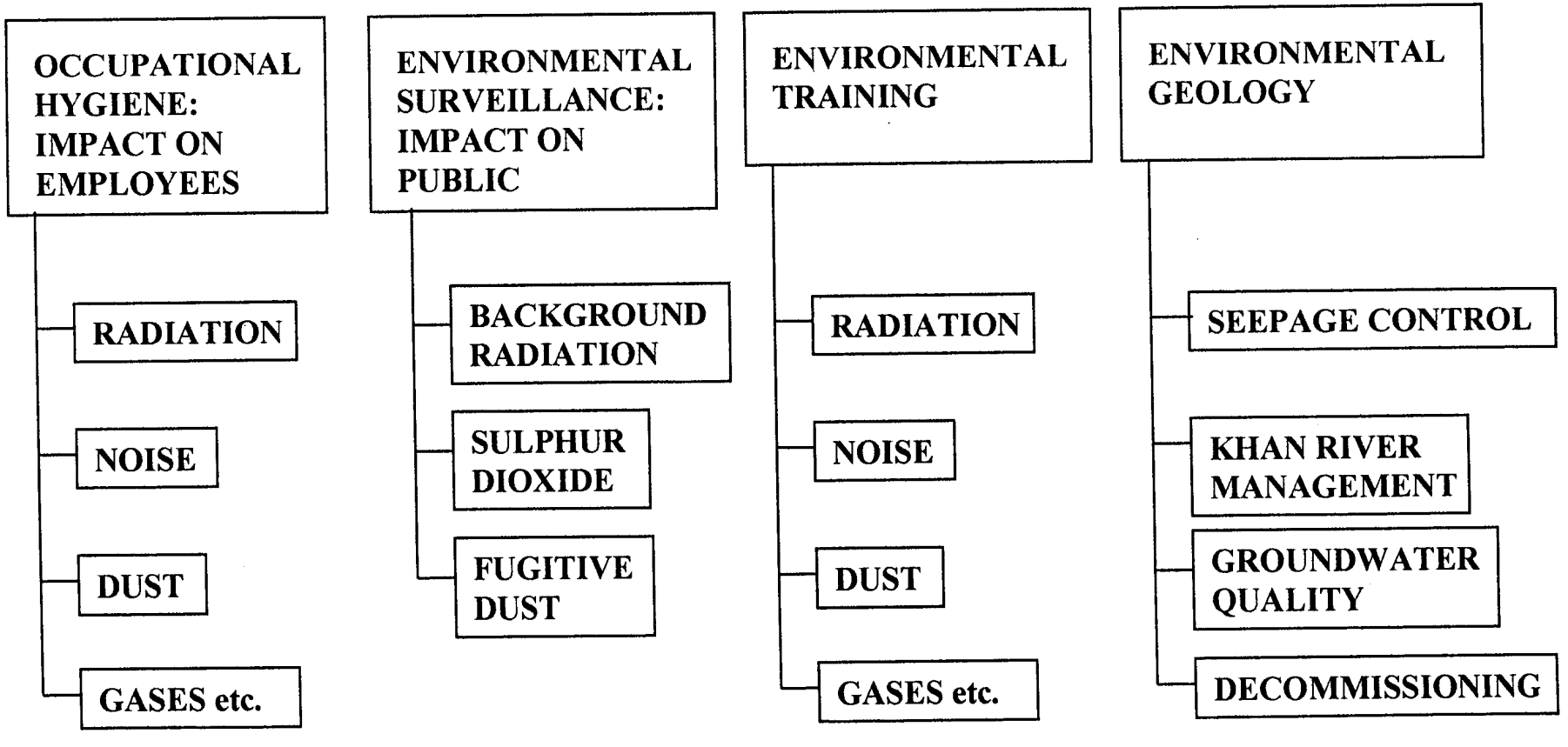


G. CONTINUOUS ION EXCHANGE: CIX(11) The clear pregnant solution now comes into contact with beads of specially-formulated resin. Uranium ions are absorbed onto the resin and are preferentially extracted from the solution. Beads are removed periodically to elution columns where a strong acid wash removes the uranium from the beads. The resulting eluate is a purified and more concentrated uranium solution.
H. SOLVENT EXTRACTION: SX(12) The acidic eluate from the ion exchange plant is mixed with an organic solvent which takes up the uranium bearing component. In a second stage, the organic solution is mixed with a neutral aqueous ammonium sulphate solution which takes up the uranium-rich 'OK liquor'. The acidic 'barren aqueous' solution is returned to the elution columns.
I. PRECIPITATION: (13) The addition of gaseous ammonia to the 'OK liquor' raises the solution pH, resulting in precipitation of ammonium diuranate, which is then thickened to a yellow slurry.



J. FILTRATION (13) The ammonium diuranate is recovered on rotating drum filters as yellow paste-'yellow cake'.
K. DRYING AND ROASTING (13) Final calcining drives off the ammonia, leaving uranium oxide. The product is then packed into metal drums. Neither ammonium diuranate nor uranium oxide are explosive substances.
L. LOADING AND DESPATCH (13) The drums of uranium oxide are loaded and exported to overseas customers for further processing. At full capacity, the plant can produce 5 000 short tons of uranium oxide each year.

Environmental Programme



B2 ENVIRONMENTAL HEALTH AND SAFETY AT RÖSSING

RTZ is a multi-national mining organisation and required that Rössing Uranium embark on comprehensive preventative programs that conform to standards consistent with world best practices. The best available technology is applied to reduce the impact of the operations on humans and the environment. Conditions potentially hazardous to the health of the inhabitants and/or ecology of the area are carefully monitored.

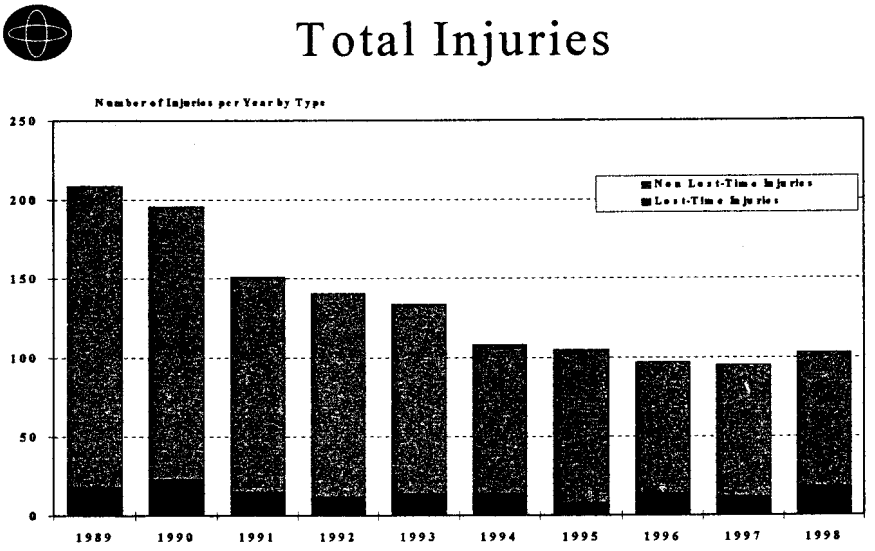
Rössing is generally regarded as a safe mine. The NOSA (National Occupational Safety Association) programme was introduced in 1978 and the first goal was set to achieve the very highest star grading achievable. This grading took place in 1980 and 3 stars were awarded. To complement the NOSA system and to uphold strong motivation amongst employees internal, sectional, departmental and divisional safety competitions were arranged and each divisional manager is responsible for the auditing of sections and departments within his division.

In the following years Rössing's health and safety programme continued, improving successfully and winning major titles in the South African NOSA competitions. In 1981 Rössing was graded a 3-star company and in 1982 it achieved the highest award, namely 5 stars. In 1983, 3 million disabling injury-free man-hours were worked and in 1984 a first place in a National Mining Competition was attained, followed by the first place in 1985 in the National Safety Effort and Efficiency (SEE) open competition. In the same year Rössing bettered the South African record for fatality-free shifts when 3 032 039 shifts were exceeded.

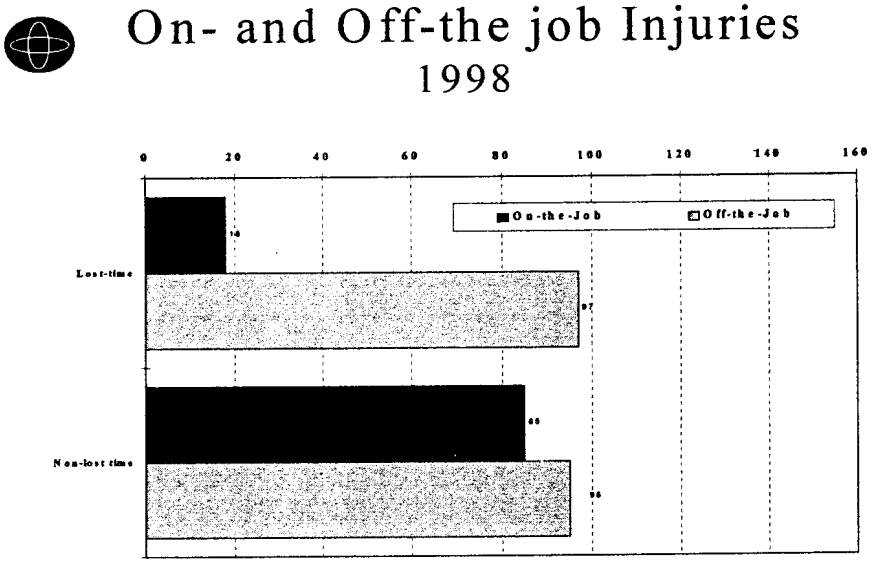
The mine achieved its first NOSCAR award (the highest safety award) in 1986 and joined the ranks of only 36 holders in Southern Africa amongst more than 4 000 participating companies, of which just over 200 are 5-star achievers. The NOSCAR was retained and re-awarded to the mine in 1987 to 1994.

In December 1988, Rössing was acknowledged by the British Safety Council as being one of the 30 safest operations in the world, and presented with the coveted Sword of Honour in recognition of this achievement. The Sword of Honour was retained in 1989 for the second consecutive year, establishing the mine as only one of three companies in the world to maintain this achievement.

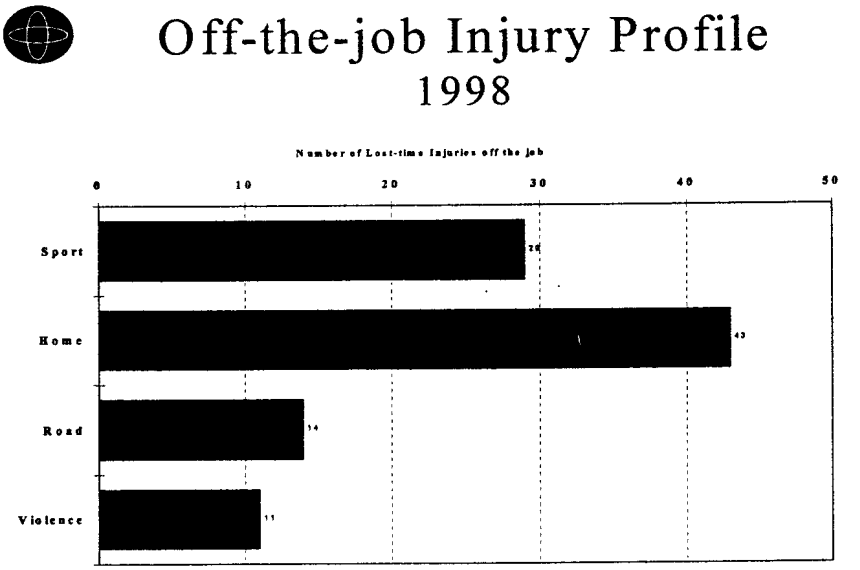
Graph 12



Graph 13



Graph 14



B3 GEOLOGY

The Rössing uranium deposit lies within the central zone of the late Pre-Cambrian Damaran Orogenic Belt that occupies much of northern Namibia.

The genesis of the uraniferous deposits commenced in Pre-Cambrian times (one thousand million years ago) during the Damaran sedimentary cycle (Vernon, 1981). The initial deposition took place in a shallow turbulent sea, and consisted of cross-bedded, coarse sediments of the lower Etusis Formation. This was followed by the deposition of silt stones, greywackes and marls that, upon later metamorphism, were converted to the rocks of the upper Etusis Formation. Subsequently, stable conditions prevailed and the fine grained and homogenous sediments of the Khan Formation accumulated. At a later stage (Hakos period) quieter and deeper water conditions developed and more heterogeneous sediments of the Rössing Formation were deposited (marble and corderite gneiss).

Approximately 500 million years ago the great Damaran orogenic movements took place. The mass of sediments began sinking to depths of about 5km and resultant temperatures and pressures caused complex folding and metamorphism of the sediments (Vernon, 1981). At about this time, and again in a later phase, the deeper lying older rocks melted to form a granitic magma that began migrating upwards. This formed the pegmatitic granite known as alaskite that contains the primary uranium. The alaskite intruded into the Hakos and upper Nosob meta sediments, such that the alaskite is now present in a range of intrusive bodies, which vary widely in texture, size and emplacement habit (Vernon, 1981; Berning, 1986; Mouillac *et al*, 1986). Since then, sedimentary rocks and basalts from the Stormberg Series of the Karoo System were deposited and have largely eroded away, leaving thin terrestrial superficial deposits.

Also at this time, numerous dolomite dykes intruded through tensurial fissures in the Pre-Cambrian rocks to the surface (Smith, 1965). These northeast and east-north-east trending dykes are still prominent features of the landscape. During the last 65 million years only superficial deposits have changed the geological landscape and large portions of the central Namib desert are covered by tertiary to recent superficial sands and duricrust deposits, such as gypscrete and calcrete (Jacob *et al*, 1986).

The Rössing orebody is unique in that it is the largest known deposit of uranium occurring in granite. The main deposit is located in the southwesterly flank of a large domal structure. The Rössing ore body is approximately 3km long and 1km wide. The uranium-bearing alaskites at Rössing are medium to coarse-grained and vary from grey to shades of pink and white. All of the primary uranium mineralisation and the majority of the secondary uranium mineralisation occur within the alaskite. The alaskite is not uniformly uraniferous and much of it lies unmineralised or of sub-economic grade (Vernon, 1982). Uraninite is the dominant radioactive mineral present and it occurs as grains ranging in size from a few microns to 0,3mm. It is included in quartz, feldspar, and biotite, but also occurs interstitially to these minerals or along cracks within them (Vernon, 1981; Berning, 1986). The arid climate is an important factor in beneficiating primary ores with secondary minerals released by weathering, and in reducing leaching by rainfall (Mouillac *et al*, 1986). The primary uranium minerals, uraninite and betaphyte give rise to secondary minerals that are usually bright yellow. Of the secondary uranium minerals, beta-uranophane is the most abundant and the mineral is not always confined to alaskite but may also be dispersed into the enveloping country rocks along cracks and fracture lines (Vernon, 1981). The average ore grade at Rössing Uranium is about 0,035% (Dames & Moore, 1984). Uraninite comprises about 53% of the uranium present in the

orebody, betaphyte less than 5% and the secondary minerals account for about 40%.

B4 MINE LOCATION AND ENVIRONMENT

The Rössing Uranium Limited (Rössing) mine and mill complex is located in the Namib Desert some 60 kilometres east-north-east of the town of Swakopmund, Namibia, at approximately 20° 27' south and 15° 02' east. The mine area is situated on the northern bank of the Khan River (a tributary of the Swakop River) 1,4 km from the river. The mine site has a mean altitude of 575m above mean sea level (a.m.s.l.).

Electrical power to the mine and the residential areas is relayed via a 220kW line. Water is pumped from sand wells in the Kuiseb River delta near Walvis Bay and from the Omaruru River delta to the north. Wells in the Khan River bed provide brackish water for dust suppression in the pit. Rössing uses between 17 000 to 27 000 cubic metres of fresh water (mostly for the process plant) and 12 000 cubic metres daily from the Khan. This water is supplemented by brackish water from the bottom of the open pit.

B5 THE CLIMATE

The Namib Desert area is dry and sometimes dusty with large variations in temperature and humidity. Precipitation is infrequent and averages less than 30mm per annum, but extremely heavy rainfalls of short duration may occur. The main elevation above sea level is 573 metres. The temperature ranges between 4,5°C and 40°C and humidity between 5% and 80%. Fog occurs on about 60 days during the night and on about 30 days during the day per annum. The precipitation from this fog is not measured.

B5.1 Winds

Surface winds tend to be from a southwesterly direction most of the year with strong easterly berg wind conditions developing in winter. Meteorological conditions combined with the effects caused by terrain features cause complex particulate and gas dispersion patterns (Earth Science Services, 1987). During the winter months (April to September) a cool down-valley wind sets in after midnight and prevails until 10:00 to 12:00. Between 11:00 and 14:00 general winds are strong and unmodified by local conditions. By 14:00 the local thermal and pressure gradients have reversed and a southwesterly up-valley wind prevails. From 15:00 to 18:00, the wind speed increases under the influence of the sea breeze. By 19:00 the sea influences precipitate, with another transition period between 22:00 and 24:00, after which the cycle is repeated. During the summer months (October to March) those parts of the cycle which are dependent on the cool air drainage are absent and the parts dependent on the heating process are more pronounced. Down-valley north easterlies are weak whilst the terminal north-westerlies prevail during the day from 08:00 to 14:00. These are interrupted by the inland penetration of afternoon sea breezes until approximately 20:00 when they are replaced by north/north westerly winds. These are relatively weak during the night but strengthen during the day and veer to become north westerly.

B5.2 Temperature

Air temperatures at Rössing vary greatly on a day-to-day basis, although seasonal variations are less marked. The mean diurnal temperatures range from 28,8°C in late autumn (May) to 15,4°C in spring (October), an annual range of 8,4°. This is very similar to the 9° range reported for Swakopmund (Goudie, 1972). Minimum temperatures are recorded in the

early morning and range from 2°C in August to 12°C in March (Earth Science Services, 1987). In contrast, the range of maximum diurnal temperatures show very little month-to-month variation, ranging from 31,8°C in July to 39°C in January, due to the occurrence of hot berg winds during the winter months. On very hot days, air temperatures measured in the Khan River gorge near Rössing may reach 44°C and some 5° higher than those measured at the mine (OJ Ashton, unpublished data). Monthly temperature ranges vary from 28° in summer to 32,9° in winter (Earth Science Services, 1987).

Whenever air temperatures are high, soil and rock temperatures reach even higher levels, particularly when they are dark. Temperatures of 60 - 70°C were recorded at the soil surface of the gravel plains of the central Namib and are similar to temperatures at Rössing.

B5.3 Humidity

Atmospheric humidity levels at Rössing are very variable on both an hour-to-hour and day-to-day basis (Earth Science Services, 1987). The lowest values (5 - 8%) are recorded at midday, whilst the highest values (up to 84%) are usually recorded during the early morning. Humidity levels rise rapidly immediately after one of the infrequent rainfalls and the afternoon sea breeze also contains appreciable humidity levels. However, these high humidity levels are usually of short duration and the diurnal average humidity level is usually below 15%.

B5.4 Radioactivity

The irregular distribution of the uraniferous material gives rise to a highly irregular radioactivity pattern for the area. It is complicated by the fact that two major radiochemical parameters affect the actual measurement of the radiation.

B5.4.1 Secular disequilibrium where the relative loss or gain of radioactive components in the ^{238}U decay chain leads to incorrect measurements;

B5.4.2 Mineralogical characteristics, in particular variations in the uranium thorium ratio and the uranium potassium ratios that affect estimates of the uranium grade, present.

The degree of disequilibrium is generally not constant within a uranium deposit and is usually higher both where secondary minerals predominate and within the zone of fluctuation of, or above, the water-table. While Rössing falls into this category, it is buffered by the arid climate prevailing in the Namib Desert. An intermediate nucleate radon 222, the noble gas daughter product of radon 226, is particularly mobile in open environs such as fracture zones or weathered rock. Background environmental radon concentrations in areas away from the uraniferous Rössing deposit (example Swakopmund) vary between 25 to 50 becquerels per m^2 (Grundlingh *et al*, 1988).

The shales in the vicinity of the Rössing mine are generally very shallow (less than 25cm) and grey-ochre in colour, with a large proportion of coarse fragments and occasional calcium carbonate concretions.

B6 THE OPERATION

The orebody is contained in granite rock known as alaskite. This ore is recovered by open pit mining and involves the removal of a series of 15 metre high benches in the pit that is 3km long and 1km wide, to a depth of 450m. Rössing is a high tonnage, low-grade mine with a stripping ratio of 2,5:1. The mining sequence is conventional drill, blast and load operation using Gardner Denver 120 drills, P & H 2100 and Marian shovels and a fleet of Wabco and Euclid 170 ST haul trucks. The material is sent to the primary crushers or to a low-grade stockpile whilst waste goes to a separate dump. Ore is delivered to the primary crushers and then by conveyor to the coarse ore stockpile.

It passes through a series of crushers and screens until the particles are 14mm in diameter. This is referred to as fine ore and, after weighing, is stored in another stockpile. The grinding process involves the wet grinding of the crushed orebody by means of steel rods and reduces it further to slurry with the consistency of mud. The four-rod mills (4,3 metres in diameter) operate in parallel.

The metallurgical process is conventional acid leach with ion exchange solution concentration and solvent extraction purification followed by precipitation of ammonium diuranate and roasting to uranium oxide. The metallurgical plant also has a pyrite burning sulphuric acid producing plant.

B6.1 Leaching

A combined leach and oxidation process takes place in large mechanically agitated tanks. The uranium content of the pulped ore is oxidised by

manganese dioxide and dissolved by the action of sulphuric acid at elevated temperatures.

B6.2 Sand/Slime Separation

The product of leaching is a solution containing suspended sand and slime. Cyclones separate these components and the sand, after washing in rotoscoops to remove traces of solution, is pumped through pipes to a tailings disposal area.

B6.3 Thickening

Counter-current decantation thickeners wash the slimes from the previous stages. The clear uranium bearing solution (pregnant solution) overflows from the No.1 thickener while the washed slime is mixed with the sands and pumped to the tailings area.

B6.4 Continuous ion exchange (CIX)

The clear pregnant solution now comes into contact with beads of specially formulated resin. Ions containing uranium are absorbed onto the resin and are preferentially extracted from the solution. Beads are removed periodically to elution columns where a strong acid wash removes the uranium from the beads. The resulting eluate contains uranium solution.

B6.5 Solvent Extraction (SX)

The acidic eluate from the ion exchange plant is mixed with an organic solvent which takes up the uranium-bearing component. In a second stage the organic solution is mixed with a neutral aqueous ammonium