

**HAEMATITE AND FERRIC OXIDE:
FERRIC OXIDE (Group 3)
HAEMATITE (Group 3)
UNDERGROUND HAEMATITE MINING WITH EXPOSURE TO
RADON (Group 1)**

A. Evidence for carcinogenicity to humans (*inadequate* for haematite and ferric oxide; *sufficient* for underground haematite mining with exposure to radon)

Underground haematite miners have a higher incidence of lung cancer in the presence of exposure to radon daughters (although other agents might also contribute to the risk) than

surface haematite miners¹⁻¹¹. Haematite mining with low-grade exposure to radon daughters and silica dust was not associated with excess lung cancer in a relatively large cohort¹². The importance of exposure to radon daughters in the occurrence of lung cancer in haematite miners is also suggested by the time trend of lung cancer rates in a mining population⁴. One mining population with an increased lung cancer risk but with current low exposure to radon daughters might have had higher exposures in the past due to poorer ventilation^{13,14}.

Some studies of metal workers exposed to ferric oxide dusts have shown an increased incidence of lung cancer^{1,15}, but the influence of factors in the workplace other than ferric oxide, i.e., soots (see p. 343), silica (see p. 341) and asbestos (see p. 106) in foundry work, cannot be discounted. In other studies of metal and chemical workers exposed to ferric oxide, the incidence of lung cancer has generally not been increased^{1,16}.

B. Evidence for carcinogenicity to animals (*inadequate for haematite; evidence suggesting lack of carcinogenicity for ferric oxide*)

No conclusive carcinogenic effect was observed in mice, hamsters or guinea-pigs given ferric oxide intratracheally or by inhalation¹. Repeated intratracheal instillation to hamsters of benzo[*a*]pyrene bound to fine ferric oxide dust particles induced squamous-cell and anaplastic carcinomas¹⁷. There was no increase in tumour yield in hamsters administered a constant dose of benzo[*a*]pyrene and increasing amounts of ferric oxide intratracheally, indicating that, beyond a certain ratio of benzo[*a*]pyrene to ferric oxide, the latter does not affect tumour yield¹⁸. Administration of ferric oxide particles alone occasionally induced interstitial fibrosis, indicating that ferrous oxide particles act as cofactors in this system, mainly as carriers¹⁹. In one study, intrapleural inoculation of the respirable fraction of iron ore mine dust to female BALB/c mice resulted in an increased incidence of lung adenomas; in a second study, an increased incidence of lymphoma/leukaemia was observed in female C57BL/6J mice exposed chronically to the same dust. In neither study was the number of animals specified, nor whether the mice were killed serially or died; in the second study, the type of exposure was not specified²⁰. In several studies in hamsters, ferric oxide was not carcinogenic when given alone but enhanced lung and nasal-cavity carcinogenesis induced by *N*-nitrosodiethylamine and *N*-nitrosodimethylamine, respectively²¹⁻²³.

C. Other relevant data

No data were available on the genetic and related effects of ferric oxide in humans. It did not induce transformation of Syrian hamster embryo cells²⁴.

References

- ¹*IARC Monographs*, 1, 29-39, 1972
- ²Damber, L. & Larsson, L.-G. (1985) Underground mining, smoking, and lung cancer: a case-control study in the iron ore municipalities in northern Sweden. *J. natl Cancer Inst.*, 74, 1207-1213

- ³Edling, C. (1982) Lung cancer and smoking in a group of iron ore miners. *Am. J. ind. Med.*, 3, 191-199
- ⁴Edling, C. & Axelson, O. (1983) Quantitative aspects of radon daughter exposure and lung cancer in underground miners. *Br. J. ind. Med.*, 40, 182-187
- ⁵Icsó, J. & Szöllösová, M. (1984) The incidence of lung cancer in the miners of iron-ore mines (Czech). *Pracov. Lék.*, 36, 294-298
- ⁶Jorgensen, H.S. (1973) A study of mortality from lung cancer among miners in Kiruna 1950-1970. *Work Environ. Health*, 10, 126-133
- ⁷Jorgensen, H.S. (1984) Lung cancer among underground workers in the iron ore mine of Kiruna based on thirty years of observation. *Ann. Acad. Med.*, 13 (Suppl.), 371-377
- ⁸Larsson, L.-G. & Damber, L. (1982) Interaction between underground mining and smoking in the causation of lung cancer: a study of nonuranium miners in northern Sweden. *Cancer Detect. Prev.*, 5, 385-389
- ⁹Radford, E.P. (1981) *Radon daughters in the induction of lung cancer in underground miners*. In: Peto, R. & Schneiderman, M., eds, *Quantification of Occupational Exposure (Banbury Report 9)*, Cold Spring Harbor, NY, CSH Press, pp. 151-163
- ¹⁰Radford, E.P. & St Clair Renard, K.G. (1984) Lung cancer in Swedish iron miners exposed to low doses of radon daughters. *New Engl. J. Med.*, 310, 1485-1494
- ¹¹St Clair Renard, K.G. (1974) Respiratory cancer mortality in an iron ore mine in northern Sweden. *Ambio*, 3, 67-69
- ¹²Lawler, A.B., Mandel, J.S., Schuman, L.M. & Lubin, J.H. (1985) A retrospective cohort mortality study of iron ore (hematite) miners in Minnesota. *J. occup. Med.*, 27, 507-517
- ¹³Anthoine, D., Braun, P., Cervoni, P., Schwartz, P. & Lamy, P. (1979) Should the lung cancer of iron miners in the Lorraine be considered an occupational disease? 270 new cases observed from 1964-1978 (Fr.). *Rev. fr. Mal. respir.*, 7, 63-65
- ¹⁴Pham, Q.T., Gaertner, M., Mur, J.M., Braun, P., Gabiano, M. & Sadoul, P. (1983) Incidence of lung cancer among iron miners. *Eur. J. respir. Dis.*, 64, 534-540
- ¹⁵Tola, S., Koskela, R.-S., Hernberg, S. & Järvinen, E. (1979) Lung cancer mortality among iron foundry workers. *J. occup. Med.*, 21, 753-760
- ¹⁶Axelson, O. & Sjöberg, A. (1979) Cancer incidence and exposure to iron oxide dust. *J. occup. Med.*, 21, 419-422
- ¹⁷Saffiotti, U. (1969) Experimental respiratory tract carcinogenesis. *Prog. exp. Tumor Res.*, 11, 302-333
- ¹⁸Sellakumar, A.R., Montesano, R., Saffiotti, U. & Kaufman, D.G. (1973) Hamster respiratory carcinogenesis induced by benzo[a]pyrene and different dose levels of ferric oxide. *J. natl Cancer Inst.*, 50, 507-510
- ¹⁹Stenbäck, F., Rowland, J. & Sellakumar, A. (1976) Carcinogenicity of benzo[a]pyrene and dusts in the hamster lung (instilled intratracheally with titanium oxide, aluminum oxide, carbon and ferric oxide). *Oncology*, 33, 29-34
- ²⁰Keast, D., Tam, N., Sheppard, N. & Papadimitriou, J.M. (1985) The role of tobacco smoke, iron ore mine dusts, viruses, and chemicals in experimental cancer. *Arch. environ. Health*, 40, 296-300
- ²¹Stenbäck, F., Ferrero, A., Montesano, R. & Shubik, P. (1973) Synergistic effect of ferric oxide on dimethylnitrosamine carcinogenesis in the Syrian golden hamster. *Z. Krebsforsch.*, 79, 31-38

- ²²Nettesheim, P., Creasia, D.A. & Mitchell, T.J. (1975) Carcinogenic and cocarcinogenic effects of inhaled synthetic smog and ferric oxide particles. *J. natl Cancer Inst.*, 55, 159-169
- ²³Feron, V.J., Emmelot, P. & Vossenaar, T. (1972) Lower respiratory tract tumours in Syrian golden hamsters after intratracheal instillations of diethylnitrosamine alone and with ferric oxide. *Eur. J. Cancer*, 8, 445-449
- ²⁴IARC Monographs, Suppl. 6, 310-311, 1987