ES473 Environmental Geology
2010 Academic Showcase Project – *Final Update April 22*

Theme Session: "Medical Geology: A Globally Emerging Discipline at the Crossroads of Earth Science and Public Health"

Outline for Theme Session

I. Medical Geology – Theme Session Introduction — TAYLOR

II. Overview of Medical Geology and Human Health

- a. Introduction, Definition, Overview of Specialty Components — KELSII DANA
- b. Example Applications and Directions for Future Work — ANGELA

III. Geologic Factors that Effect Human Health

- a. Overview-Minerals-Rocks-Regolith — JODY BERG
- b. Water Resources — MAC

IV. Biogeochemical Interactions — KAILEY

V. Anthropogenic Factors, Land-use and Human Health — MARC D

VI. Techniques and Methods in the Study of Medical Geology

- a. Overview and Geochemistry — DAN D
- b. Epidemiology and Geospatial Analysis — BILL
- c. Geospatial Distribution and Regional Medical Geology — ALYSSA M.

VII. Case Studies

- a. Volcanic Eruptions — KEVIN
- b. Dust — CARLIE
- c. Radon — JONI
- d. Metals and Industrial Minerals
  - i. Arsenic Part I – Statement of Problem and Global Examples — RICCI
  - ii. Arsenic Part II – Health Effects and Application to Oregon — VON
  - iii. Selenium — CAITLIN
  - iv. Iodine & Mercury — TRISTA
  - v. Coal & Fibrous Minerals — KACEY
- e. Animals and Medical Geology — RACHEL
- f. Geophagy (soil ingestion) — LINDSEY

FOUNDATIONAL READING LIST AND BIBLIOGRAPHY

Benchmark References

Appleton, Fuge, and McCall, eds., 1996, Environmental Geochemistry and Health: Geological Society of London Special Publication No. 113, p. 239-244.

Komatina, M.M., 2004, Medical Geology – Effects of Geological Environments on Human Health: Elsevier, 488 p.

National Research Council (U.S.), 2007, Earth materials and health : research priorities for earth science and public health: Washington, D.C. : National Academies Press, 176 p.

Selinus, O., ed., 2005, Essentials of Medical Geology, Elsevier, 812 p.

Skinner, H.C. and Berger, A.R., eds., 2003, Geology and Health – Closing the Gap: Oxford University Press, 179 p.

I. OVERVIEW OF MEDICAL GEOLOGY AND HUMAN HEALTH

a. Introduction, Definition, Overview of Specialty Components [Kelsii]

Berger, 2003, Overview / Linking of Health and Geology, in Skinner and Berger ***(PDF ON FILE)***

Bunnell, 2004, Medical Geology: Emerging Discipline on the Ecosystem–Human Health Interface: Ecohealth, v. 1, p. 15-18. ***(PDF ON FILE)***

Bunnell, J. E., Finkelman, R. B., Centeno, J. A., and Selinus, 2007, Medical Geology: A globally emerging discipline. Geologica Acta, Vol. 5, no. 3, p. 273-281. ***(PDF ON FILE)***

Finkleman et al., 2005, Medical geology – The emergence of a new discipline: Terrae, v. 2., p. 3-8. ***(PDF ON FILE)***

Finkleman et al., 200X, Medical geology – An emerging discipline: ??? ***(PDF ON FILE)***

Komatina, 2004, Chapter 1 – Introduction and Overview ***(PDF ON FILE)***

Singh, 200X, Theoretical Basis For Medical Geology: ??? ***(PDF ON FILE)***

Weinstein and Selinus, 200X, Nature and Medicine – A break through for human health: International Year of Planet Earth, www.yearofplanetearth.org ***(PDF ON FILE)***

b. Example Applications and Directions for Future Work [Angela]

Bowman et al., 2003, Medical Geology – New Relevance in the Earth Sciences, Episodes, v. 26, no. 4, p. 270-278. ***(PDF ON FILE)***

Cook et al., 2004, Geological factors in the emergence of infectious disease: Proceedings of the XXV Congress of the International Academy of Pathology, p. 3131-3135. ***(PDF ON FILE)***

Davies et al., 2005, Medical Geology perspectives, in Selinus, 2005 ***(PDF ON FILE)***

Dissanayake, 2005, Of stones and health – Medical geology in Sri Lanka: Science, v. 309, p. 883-885. ***(PDF ON FILE)***

NRC, 2007, Chapter 9 – Collaborative Research Opportunities **(PDF ON FILE)**

Selinus, 2004, Medical Geology: an emerging speciality: Terrae, v. 1., p. 8-15. ***(PDF ON FILE)***

Selinus, O., 2007, Medical Geology – An Opportunity for the Future: Ambio, v. 36, no. 1, p. 114-116. ***(PDF ON FILE)***

Selinus and Frank, 2000, Chapter 10 – Medical Geology, in Moller, ed., Environmental Medicine: Joint Industrial Safety Council of Sweden, Publishers, p. 164-182. ***(PDF ON FILE)***

Selinus et al., 2007, The Medical Geology Revolution: Episodes, v. 30, no. 4, p. 305-309. ***(PDF ON FILE)***

Selinus et al., 2008, Medical Geology – A new future for geology: European Geologist ***(PDF ON FILE)***

II. GEOLOGIC FACTORS THAT EFFECT HUMAN HEALTH

a. Overview-Minerals-Rocks-Regolith [Jody Berg]

Alloway, 2005, Bioavailability of Elements in Soil, in Selinus, 2005 ***(PDF ON FILE)***

Finkelman, R. B. and Limpitlaw, U., 2006, Health benefits of geologic materials and geologic processes. International Journal of Environmental Research and Public Health, Vol. 3, no. 4, p. 278-283.

NRC, 2007, Chapter 2 – Earth Processes and Human Physiology ***(PDF ON FILE)***

NRC, 2007, Chapter 6 – Earth Perturbations and Public Health Impacts ***(PDF ON FILE)***

Skinner, 2005, Mineralology in Bone, in Selinus, 2005 ***(PDF ON FILE)***

Edmunds W.M. and Smedley P.L., 1995, Minerals, water and health: Mineralogical Society Bulletin no.106 p.3-7

Komatina, 2004, Chapter 2 – Overview Geological Factors that Effect Human Health (rock/tectonic framework) ***(PDF ON FILE)***

b. Water Resources [Mac]

Bowell, 1996b, Biogeochemical factors affecting groundwater quality in Tanzania, IN: J.D.Appleton, R.Fuge & G.J.H.McCall (ed), Environmental geochemistry and health: with special reference to developing countries. London: Geological Society of London (Special Publication no.113) ***(PDF ON FILE)***

Edmunds, W.M. and Smedley, P.L., 1996, Groundwater geochemistry and health: an overview : IN: J.D.Appleton, R.Fuge & G.J.H.McCall (ed), Environmental geochemistry and health: with special reference to developing countries. London: Geological Society of London (Special Publication no.113) p.91-105 ***(PDF ON FILE)***

Komatina, 2004, Chapter 3 – Other Natural (Environmental) Factors (water resources) ***(PDF ON FILE)***

Neal, 2003, Surface and Groundwater Quality and Human Health – Overview, in Skinner and Berger ***(PDF ON FILE)***

NRC, 2007, Chapter 4 – What we drink ***(PDF ON FILE)***

Rubenowitz and Hiscock, 2005, Water Hardness and Health, in Selinus, 2005 ***(PDF ON FILE)***

III. BIOGEOCHEMICAL REACTIONS [Kailey]

Lindh, 2005A, Biochemical Uptake of Chemical Elements, in Selinus, 2005 ***(PDF ON FILE)***

Lindh, 2005B, Biological Functions of Elements, in Selinus, 2005 ***(PDF ON FILE)***

Selinus, 2003, Biogeochemical Monitoring in Medical Geology – Methods and Practice, in Skinner and Berger ***(PDF ON FILE)***

Selinus, O., Finkelman, Robert B., and Centeno, Jose, A., 2006, Medical problems related to geology and ecosystem interaction. In Geology and Ecosystems, Igor S. Zektser and Brian Marker, eds., Springer, Chapter 16, p.197-218.

Selinus and Galgan, 1996, Biogeochemistry and metal biology IN: J.D.Appleton, R.Fuge & G.J.H.McCall (ed), Environmental geochemistry and health: with special reference to developing countries. London: Geological Society of London (Special Publication no.113) ***(PDF ON FILE)***

Steinnes, 2003, Biogeochemical Cycling of Selenium and Iodine – Implications for Geomedicine, in Skinner and Berger ***(PDF ON FILE)***

IV. ANTHROPOGENIC FACTORS, LAND-USE AND HUMAN HEALTH [Marc D]

Fuge, 2005, Anthropogenic Sources, in Selinus, 2005 ***(PDF ON FILE)***

Komatina, 2004, Chapter 4 – Anthropogenic (man-made) Factors (pollution and land-use) ***(PDF ON FILE)***

V. TECHNIQUES AND METHODS IN THE STUDY OF MEDICAL GEOLOGY

a. Overview and Geochemistry [Dan D]

Appleton J D, Fuge R and McCall G J H. (eds). Environmental Geochemistry and Health, Geological Society Special Publication No 113. London. 23-37.

Centeno et al., 2005, Environmental Pathology, in Selinus, 2005 ***(PDF ON FILE)***

Fordyce F M and Smith B., 1997, The link between geochemistry and health. Earthwise 10. 21.

Fowles et al., 2005, Environmental Medicine, in Selinus, 2005 ***(PDF ON FILE)***

Komatina, 2004, Chapter 7-8 – Procedures and methods in Medical Geology ***(PDF ON FILE)***

Plant et al., 2003, Global Environmental Geochemistry, in Skinner and Berger ***(PDF ON FILE)***

b. Epidemiology and Geospatial Distribution [Bill V.]

Bunnell et al., 2005, GIS in Human Health Studies, in Selinus, 2005 ***(PDF ON FILE)***

Cook, A., Finkelman, R., and Weinstein, P. Geological factors in the emergence of infectious disease. Pathology International 54 (Supp. 1): S131-5 (2004).

Nielsen and Jensen, 2005, Environmental Epidemiology, in Selinus, 2005 ***(PDF ON FILE)***

NRC, 2007, Chapter 7 – GIScience, Remote Sensing and Epidemiology

Plant et al., 1996, The role of geochemistry in environmental and epidemiological studies, IN: J.D.Appleton, R.Fuge & G.J.H.McCall (ed), Environmental geochemistry and health: with special reference to developing countries. London: Geological Society of London (Special Publication no.113) ***(PDF ON FILE)***

Weinstein and Cook, 2007, Epidemiological Transitions and the Changing Face of Medical Geology, Ambio, v. 36, no. 1 ***(PDF ON FILE)***

c. Geospatial Distribution and Regional Medical Geology [Alyssa M.]

Davies, 2003, Case Study: Geomedical Health Conditions in Africa, in Skinner and Berger ***(PDF ON FILE)***

Komatina, 2004, Chapter 6 – Geospatial Distribution of Human Health and Disease ***(PDF ON FILE)***

Komatina, 2004, Chapter 7-8 – Procedures and methods in Medical Geology ***(PDF ON FILE)***

Komatina, 2004, Chapter 9 –Regional Medical Geology (spatial distribution, geo-processes and health) ***(PDF ON FILE)***

NRC, 2007, Chapter 7 – GIScience, Remote Sensing and Epidemiology

Pereira et al., 2007, Strengthening Environmental Health in Malaysia – Linking Medical Geology to Health and the Environment: ??? ***(PDF ON FILE)***

VI. CASE STUDIES

Komatina, 2004, Chapter 10 – Applied Medical Geology and Case Studies ***(PDF ON FILE)***

a. Volcanic Eruptions [Kevin]

Durand M, Florkowski C, George P, Walmsley T, Weinstein P and Cole, J. Elevated trace element output in urine following acute volcanic gas exposure. Journal of Volcanology and Geothermal Research 134: 139-48 (2004) **(PDF ON FILE)**

Grattan et al., 2003, Case Study: Human Sickness and Volcanic Eruptions, in Skinner and Berger ***(PDF ON FILE)***

Hickling J., Clements M., Weinstein P. and Woodward A. Acute health effects of the Mt. Ruapehu (New Zealand) volcanic eruption of June 1996. International Journal of Environmental Health Research 9: 97-107 (1999)

Nicholson et al., 1996, Acid and gas contamination at Poas Volcano, Costa Rica, IN: J.D.Appleton, R.Fuge & G.J.H.McCall (ed), Environmental geochemistry and health: with special reference to developing countries. London: Geological Society of London (Special Publication no.113) ***(PDF ON FILE)***

Weinstein, P. and Cook, 2002, A. Human health impacts of volcanic eruptions. Histopathology 41 (Supp.2) 329-333.

Weinstein and Cook, 2005, Volcanic Emissions and Health, in Selinus, 2005 ***(PDF ON FILE)***

b. Dust [Carlie]

Derbyshire, 2003, Case Study: Natural Dust and Pneumoconiosis in Asia, in Skinner and Berger ***(PDF ON FILE)***

Derbyshire, 2005, Natural Dust and Human Health, in Selinus, 2005 ***(PDF ON FILE)***

Derbyshire, 2007, Natural Minerogenic Dust and Human Health: Ambio, v. 36, no. 1 ***(PDF ON FILE)***

NRC, 2007, Chapter 3 – What we breathe ***(PDF ON FILE)***

c. Radon [Joni]

Appleton, J D., 1999, Radon potential maps : identification of at-risk areas: In: Earthwise No. 13 p. 14

Appleton, 2007, Radon: Sources, Health Risks, and Hazard Mapping: Ambio, v. 36, no. 1 ***(PDF ON FILE)***

Appleton, 2005, Radon in Air and Water, in Selinus, 2005 ***(PDF ON FILE)***

Talbot, D.K. Appleton, J.D. Ball T.K. & Strutt M.H., 1998, A comparison of field and laboratory analytical methods for radon site investigation: Journal of Geochemical Exploration 65(1) p.79-90.

d. Metals and Industrial Minerals

i. Arsenic Part I – Statement of Problem and Global Examples [Ricci]

Breward N and Williams T M., 1994 Arsenic and mercury pollution in gold mining: IN: Mining Environmental Magazine 1994 p25-27

Centeno et al., 2007, Global Impacts of Geogenic Arsenic: A Medical Geology Research Case: Ambio, v. 36, no. 1 ***(PDF ON FILE)***

Johnson, C.C. Rawlins, B.G. Breward, N., 2004, The British Geological Survey's geochemical baseline survey of the environment : arsenic in soil: In: Geochimica et Cosmochimica Acta Vol. 68 pt/no 11S Special supplement p A537

Smedley, P.L. ; Pelig-Ba, K.B. and Edmunds, W.M., 1996, Mobility of arsenic in groundwater in the Obuasi gold-mining area of Ghana: some implications for human health : IN: J.D.Appleton, R.Fuge & G.J.H.McCall (ed), 1996, Environmental geochemistry and health: with special reference to developing countries. London: Geological Society of London (Special Publication no.113) p.163-181 ***(PDF ON FILE)***

Smedley, P.L. and Edmunds, W.M.A., 2002, Review of the source, behaviour and distribution of arsenic in natural waters : In: Applied Geochemistry 17(5) p.517-567

Smedley, P.L. and MacDonald, D.M.J., 2002, Hydrogeochemistry of arsenic and other inorganic constituents in groundwaters from La Pampa, Argentina: In: Applied Geochemistry 17(3) p.259-284

Thornton, 1996, Sources and pathways of arsenic in the geologic environment, IN: J.D.Appleton, R.Fuge & G.J.H.McCall (ed), Environmental geochemistry and health: with special reference to developing countries. London: Geological Society of London (Special Publication no.113) ***(PDF ON FILE)***

Tsing et al., 2007, Blackfoot Disease in Taiwan: Its Link with Inorganic Arsenic Exposure from Drinking Water: Ambio, v. 36, no. 1 ***(PDF ON FILE)***

Williams T M, Fordyce F M, Paijitprapapon A and Charoenchaisri, P., 2007, Arsenic contamination in surface drainage and groundwater in part of the SE Asian tin belt, Nakon Si Thammarat Province, Southern Thailand. Environmental Geology 27. 16-33.

Fordyce et al., 2003, Case Study: Natural Iodine Occurrence in Sri Lanka, in Skinner and Berger ***(PDF ON FILE)***

ii. Arsenic Part II – Health Effects and Application to Oregon [Von]

Hinkle and Pollette, 1999, Arsenic in Groundwater of the Willamette Basin **(PDF ON FILE)**

Naidu and Nadebaum, 2003, Case Study: Natural Arsenic and Toxicity Problems, in Skinner and Berger ***(PDF ON FILE)***

Oregon Public Health Dept., 2009, Sutherlin Valley Groundwater Arsenic Study **(PDF ON FILE)**

Tchounwou PB, Centeno JA and Patlolla AK, 2004, Arsenic toxicity, mutagenesis and carcinogenesis - a health risk assessment and management approach. Molecular and Cellular Biochemistry 255: 47-55.

Whanger et al., 1977, Arsenic in Oregon Waters **(PDF ON FILE)**

Wuyi et al., 2003, Case Study: Aresenic and Selenium Toxicity, in Skinner and Berger ***(PDF ON FILE)***

iii. Selenium [Caitlin]

Appleton J D, Fordyce F M and Johnson C C., 1999, Red rice or a red herring? Links between environmental iodine, selenium, diet and goitre in Sri Lanka. Earthworks Issue 6. 3.

Christian JW, Hopenhayn C*, Centeno JA, Todorov TI., 2006, Distribution of urinary selenium and arsenic among pregnant women exposed to arsenic in drinking water. Environ Res;100:115-122.

Fordyce, 2005, Selenium Deficiency and Toxicity, in Selinus, 2005 ***(PDF ON FILE)***

Fordyce, 2007, Selenium Geochemistry and Health: Ambio, v. 36, no. 1 ***(PDF ON FILE)***

Fordyce F M, Zhang G, Green K and Xinping L., 2000, Soil, grain and water chemistry in relation to human selenium responsive diseases in Enshi District, China. Applied Geochemistry 15. 117-132.

Johnson, C.C. Ge, X. Green, K.A. and Liu X., 2000, Selenium distribution in the local environment of selected villages of the Keshan Disease belt, Zhangjiakou District, Hebei Province, People's Republic of China: IN: Applied Geochemistry 15(3) p385-401

Li, 2007, Selenium Deficiency and Endemic Heart Failure in China: A Case Study of Biogeochemistry for Human Health: Ambio, v. 36, no. 1 ***(PDF ON FILE)***

Wuyi et al., 2003, Case Study: Aresenic and Selenium Toxicity, in Skinner and Berger ***(PDF ON FILE)***

Fordyce et al., 2003, Case Study: Natural Iodine Occurrence in Sri Lanka, in Skinner and Berger ***(PDF ON FILE)***

iv. Iodine and Mercury [Trista]

Appleton J D, Fordyce F M and Johnson C C., 1999, Red rice or a red herring? Links between environmental iodine, selenium, diet and goitre in Sri Lanka. Earthworks Issue 6. 3.

Dissanayake and Chandrajith, 1996, Iodine in the environment and endemic goiter in Sri Lanka, IN: J.D.Appleton, R.Fuge & G.J.H.McCall (ed), Environmental geochemistry and health: with special reference to developing countries. London: Geological Society of London (Special Publication no.113) ***(PDF ON FILE)***

Fordyce F M, Johnson C C, Navaratne U R B, Appleton J D and Dissanayake C B., 2000, Selenium and iodine in soil, rice and drinking water in relation to endemic goitre in Sri Lanka. The Science of the Total Environment. 263/1-3. 127-142

Fuge, 2005, Soils and Iodine Deficiency, in Selinus, 2005 ***(PDF ON FILE)***

Fuge, 2007, Iodine Deficiency: An Ancient Problem in a Modern World: Ambio, v. 36, no. 1 ***(PDF ON FILE)***

Taylor, H. Appleton, J.D. Lister, T.R. Chitamweba, D. Mkumbo, O. Tesha, A.L. Beinhoff, C. and Veiga, M.M., 2004, Exposure to environmental mercury in the Rwamagasa artisanal gold mining area, Geita District, Tanzania: In: Materials and Geoenvironment Vol 51 pt/no 1 (2004) p 294-297

Taylor, H. Appleton, J.D. Lister, T.R. Smith, B. Chitamweba, D. Mkumbo, O. Machiwa, J.F. Tesha, A.L. and Beinhoff, C., 2005, Environmental assessment of mercury contamination from the Rwamagaza artisanal gold mining centre, Geita district, Tanzania: In: Science of the Total Environment Vol 343 pt/no 1-3 p 111-133

v. Coal and Fibrous Minerals [Kacey]

Finkelman et al., 2003, Case Study: Coal Combustion and Human Health in China, in Skinner and Berger ***(PDF ON FILE)***

Finkelman RB, Belkin HE, Centeno JA. Health Impacts of Coal – Should we be concerned? Geotimes 2006;30:31-35.

Finkelman, 2007, Health Impacts of Coal: Facts and Fallacies: Ambio, v. 36, no. 1 ***(PDF ON FILE)***

Gray MA, Centeno JA*, Slaney DP, Ejnik JW, Todorov TI, Nacey JN. Environmental exposure to trace elements and prostate cancer in three New Zealand ethnic groups. Int J Environ Res Public Health 2005;2(3):374-384.

Hillerdal, 2003, Health Problems Related to Environmental Fibrous Minerals, in Skinner and Berger ***(PDF ON FILE)***

Orem et al., 2007, Health Effects of Toxic Organic Substances from Coal: Toward "Panendemic" Nephropathy: Ambio, v. 36, no. 1 ***(PDF ON FILE)***

Robbins and Harthill, 2003, Life in Copper Province, in Skinner and Berger ***(PDF ON FILE)***

Smedley and Kinniburgh, 2005, Arsenic in Groundwater and the Environment, in Selinus, 2005 ***(PDF ON FILE)***

Wang et al., 2006, Arsenic concentrations in Chinese coals: Science of the Total Environment 357, p. 96– 102 ***(PDF ON FILE)***

Zheng, B., Wu, D., Wang, B., Liu, X., Wang, M., Wang, A., Xiao, G., Liu, P. and Finkelman, 2006, Fluorosis caused by indoor coal combustion in China: discovery and progress. Journal of Environmental Geochemistry and Health. P.

e. Animals and Medical Geology [Rachel]

Bowell et al., 1996a, Formation of cave salts and utilization by elephants in Kenya, IN: J.D.Appleton, R.Fuge & G.J.H.McCall (ed), Environmental geochemistry and health: with special reference to developing countries. London: Geological Society of London (Special Publication no.113) ***(PDF ON FILE)***

Fordyce et al., 1996, Stream sediment, soil, and forage chemistry of cattle health in Zimbabwe, IN: J.D.Appleton, R.Fuge & G.J.H.McCall (ed), Environmental geochemistry and health: with special reference to developing countries. London: Geological Society of London (Special Publication no.113) ***(PDF ON FILE)***

Frank, 2003, Molybdenosis Leading to Type 2 Diabetes Mellitus in Swedish Moose, in Skinner and Berger ***(PDF ON FILE)***

Gough et al., 2003, Cadmium Accumulation in Browse Vegetation, Alaska – Implications for Animal Health, in Skinner and Berger ***(PDF ON FILE)***

Jones, 2005, Animals and Medical Geology, in Selinus, 2005 ***(PDF ON FILE)***

Maskall and Thornton, 1996, Trace elements in Kenyan soils and implications for wildlife health, IN: J.D.Appleton, R.Fuge & G.J.H.McCall (ed), Environmental geochemistry and health: with special reference to developing countries. London: Geological Society of London (Special Publication no.113) ***(PDF ON FILE)***

Skinner, 2003, Geochemistry and Vertebrate Bones, in Skinner and Berger ***(PDF ON FILE)***

f. **Geophagy (soil ingestion) [Lindsey]**

Abrahams, 2005, Geophagy and the involuntary ingestion of soil, in Selinus, 2005 ***(PDF ON FILE)***

Abrahams, P.W. Follansbee, M.H. Hunt, A. Smith, B. and Wragg, J., 2006, Iron nutrition and possible lead toxicity : an appraisal of geophagy undertaken by pregnant women of UK Asian communities: In: Applied Geochemistry Vol. 26 p. 98-108

Bultman, 2005, The ecology of soil-borne human pathogens, in Selinus, 2005 ***(PDF ON FILE)***

Gomes and Silva, 2007, Minerals and clay minerals in medical geology: Applied Clay Science v/ 36, p. 4–21 ***(PDF ON FILE)***

NRC, 2007, Chapter 5 – What we eat

Smith, B. Rawlins, B.G. Cordeiro, M.J.A.R. and Hutchins, M.G., 2000, The bioaccessibility of essential and potentially toxic trace elements in tropical soils from Mukono District, Uganda: Journal of the Geological Society of London 157(4) p.885-8921998 Williams, T.M. Rawlins,

Tateo and Summa, 2007, Element mobility in clays for healing use: Applied Clay Science v. 36, p. 64–76 ***(PDF ON FILE)***