KOLLOIDIEN MUODOSTUMINEN JA NIIDEN OSUUS RADIONUKLIDIEN KULJETTAJINA (KOLKU)

RELEVANCE OF COLLOIDS IN PROMOTING THE TRANSPORT OF RADIONUCLIDES

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Background

Colloid-facilitated transport of radionuclides may be significant to the long-term performance of a spent nuclear fuel repository

Buddemeier, R.W. and Hunt, J.R., 1988. Transport of colloidal contaminants in groundwater: Radionuclide migration at the Nevada test site. *Applied Geochemistry 3, 535-548.*

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Novikov, A.P., Kalmykov, S.N., Utsunomiya, S., Ewing, R.C., Horreard, F., Merkulov, A., Clark, S.B., Tkachev, V.V., Myasoedov, B.F., 2006. Colloid transport of plutonium in the far field of the Mayak production association, Russia. *Science 314, 638-641*.

Yamaguchi, T., Nakayama, S., Vandergraaf, T.T., Drew, D.J., Vilks, P., 2008. Radionuclide and colloid migration in quarried block of granite under in-situ conditions at a depth of 240 m.

Journal of Power and Energy Systems 2, 186-197.

Colloid studies in Finland

Laaksoharju, M., Vuorinen, U., Snellman, M., Allard, B., Petterson, C., Helenius, J. and Hinkkanen, H., 1994. Colloids or Artefacts? A TVO/SKB Co-Operation Project in Olkiluoto, Finland. *Report YJT-94-01*.

Vuorinen, U. and Hirvonen, H., 2005. Bentonite as a Colloid Source in Groundwater at Olkiluoto. *Posiva WR 2005-03*.

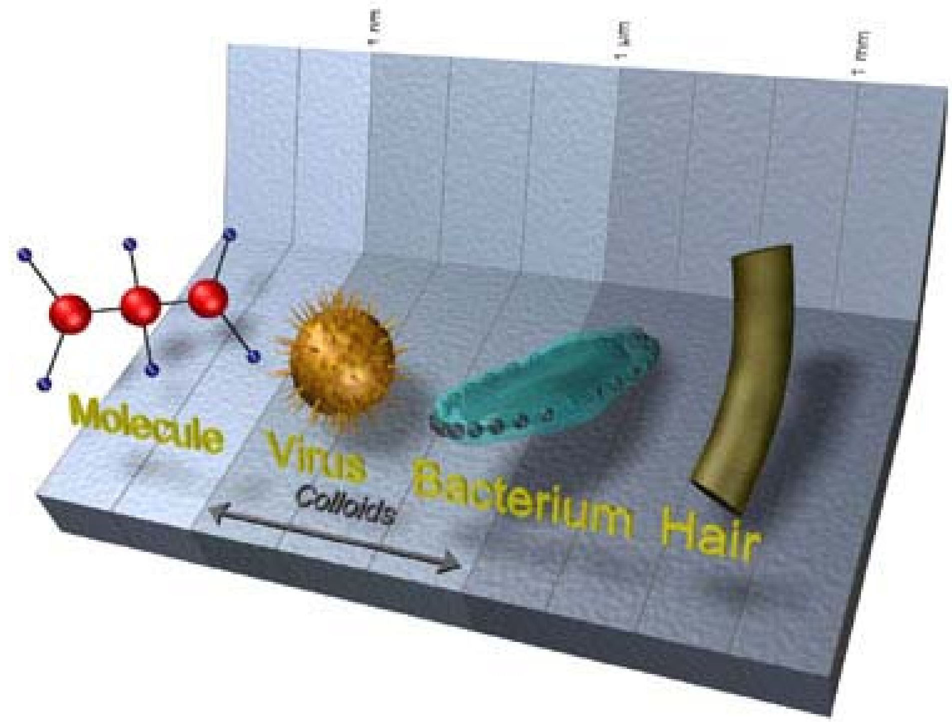
Takala, M. and Manninen, P., 2006a. Sampling and Analysis of Groundwater Colloids–A literature review. *Posiva WR-2006-15*.

Takala, M. and Manninen, P., 2006b. Sampling and Characterisation of Groundwater Colloids at ONKALO, Olkiluoto, Finland. *Posiva WR-2006-98*.

Hölttä, P. and Hakanen, M., 2008. Silica Colloids and their Effect on Radionuclide Sorption – A Literature Review. *Posiva WR-2008-29*.

Hölttä, P. and Hakanen, M., 2008b. Silica Colloids and their Effect on Radionuclide Sorption – Experimental work. *Posiva WR-2008-00.*

Colloids



In a colloidal system solid particles are dispersed in liquid to form suspension.

Particle size ranges from 1 nm to 1µm in diameter.

Due to surface charge colloid transport is significantly different to that of a solute.

High surface-to-volume ratio → surface chemistry very important in the study of colloidal systems.

Colloid formation

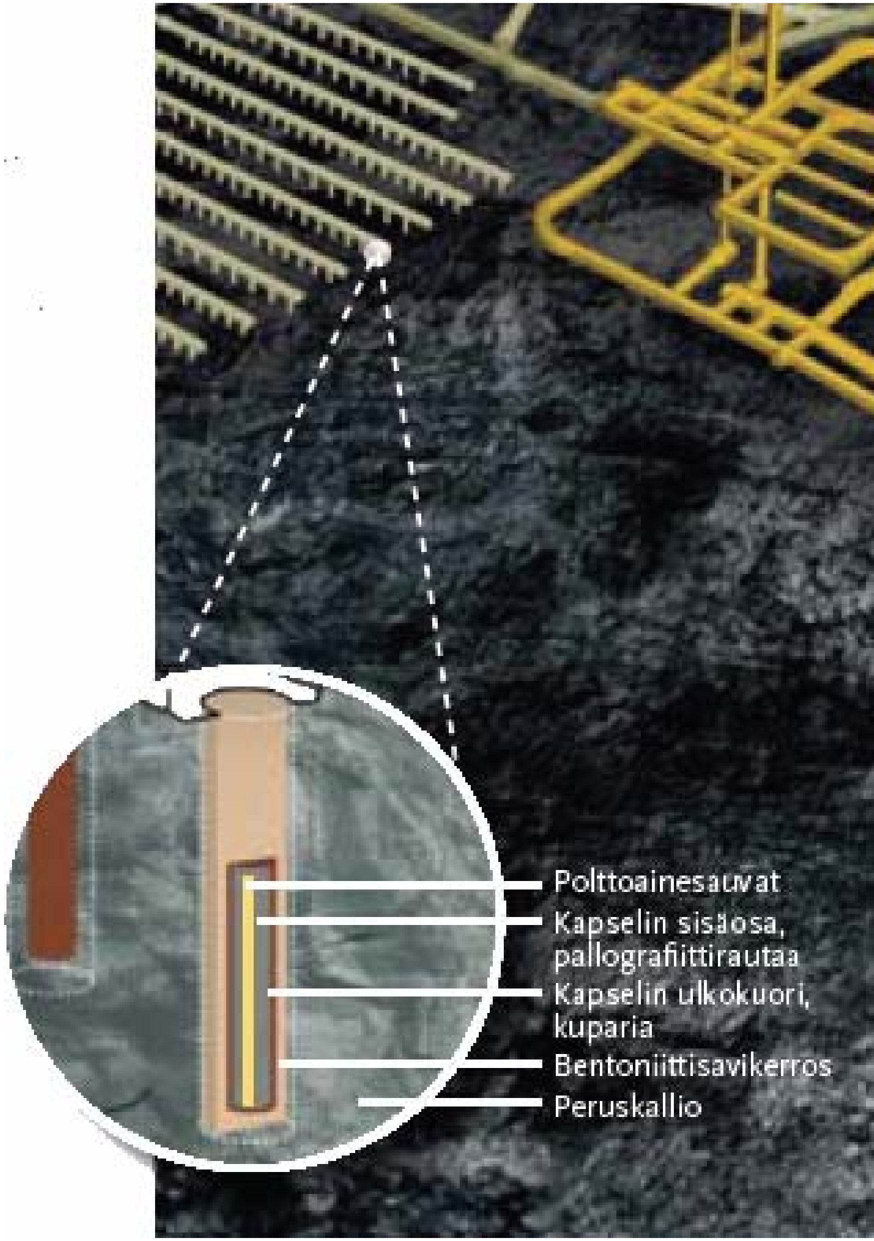
Inorganic colloids are present in all natural ground waters, they are formed by dissolution from e.g. silica based minerals.

Colloids are also produced from: Degraded Engineered Barrier System (EBS) materials: bentonite clay barrier, copper or steel container.

Grouting materials: cement, silica sol.

Uranium fuel itself.

Release of natural colloids can be enhanced due to drilling and excavation.



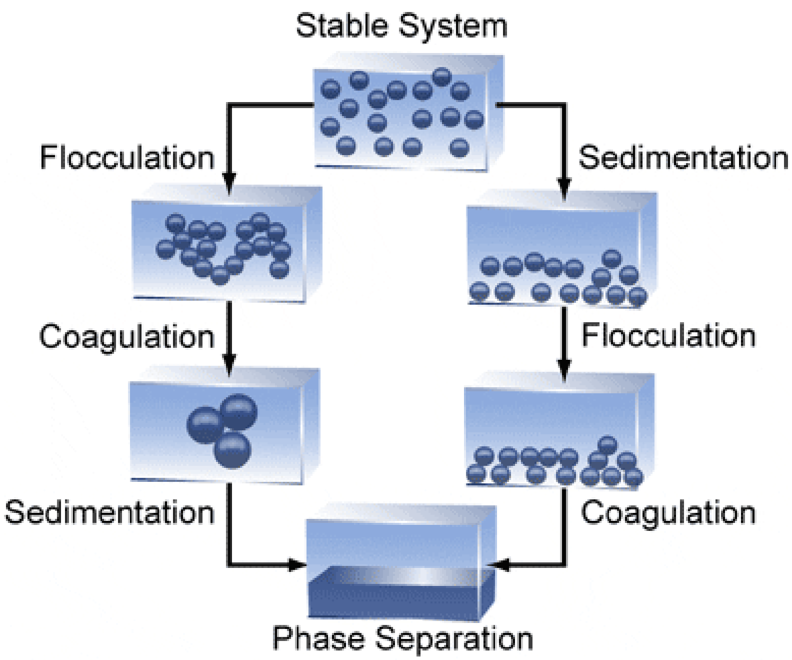
Colloid stability and mobility

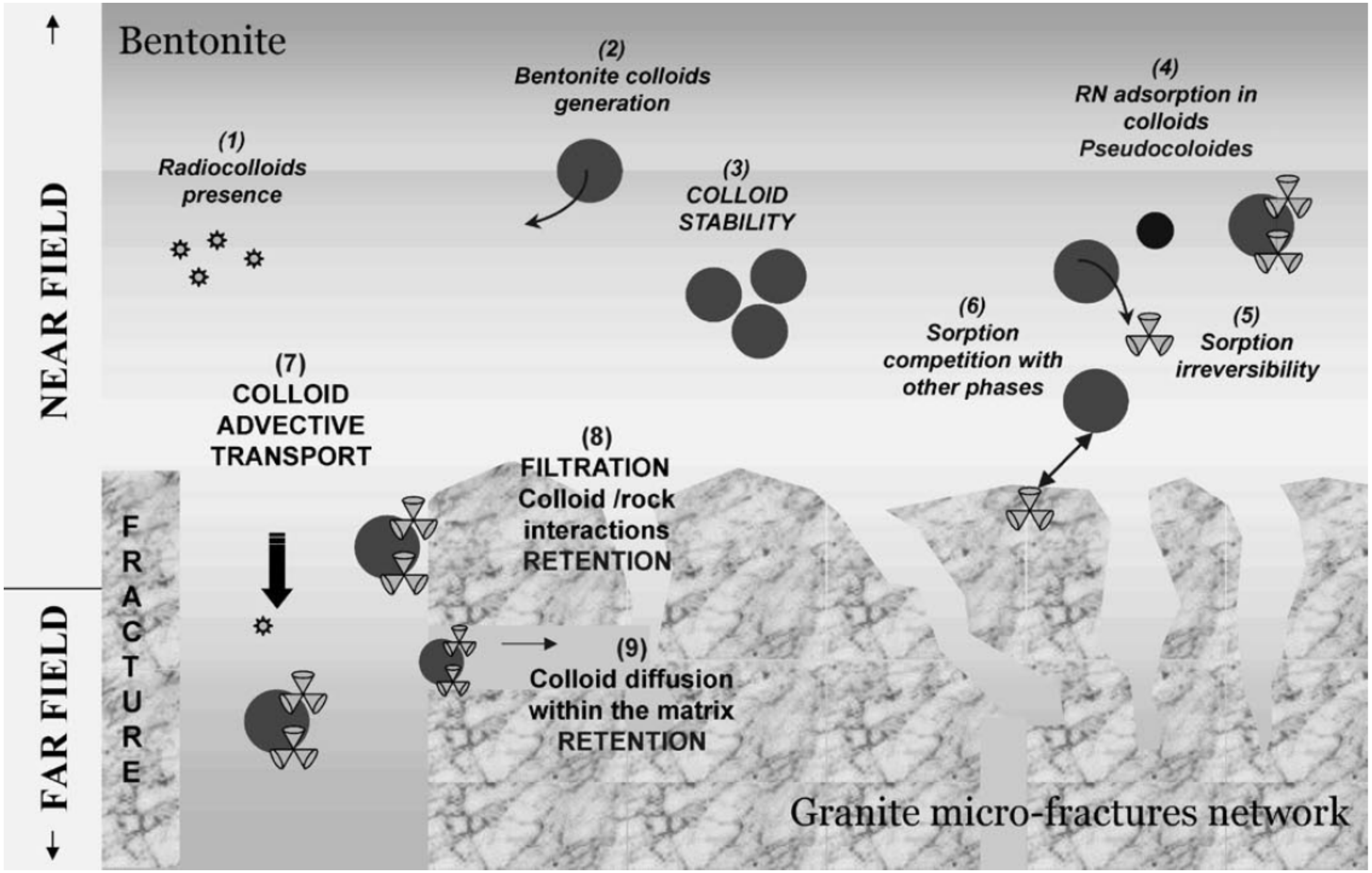
The stability of a colloidal system is determined by the sum of the van der Waals attractive and electrical double layer repulsive forces that exist between particles as they approach each other due to the Brownian motion.

Zeta potential is a measure of the magnitude of the repulsion or attraction between particles.

Stability dependents on zeta potential, particle size, pH and salinity.

Low salinity waters (10^{-3} M) favours colloid stability (glacial melt water diluted groundwater)





Schematic diagram of the colloid processes necessary to inspect at the bentonite/ granite interface in order to assess their importance for radionuclide migration. (Alonso et al., 2006)

Kuru Grey:

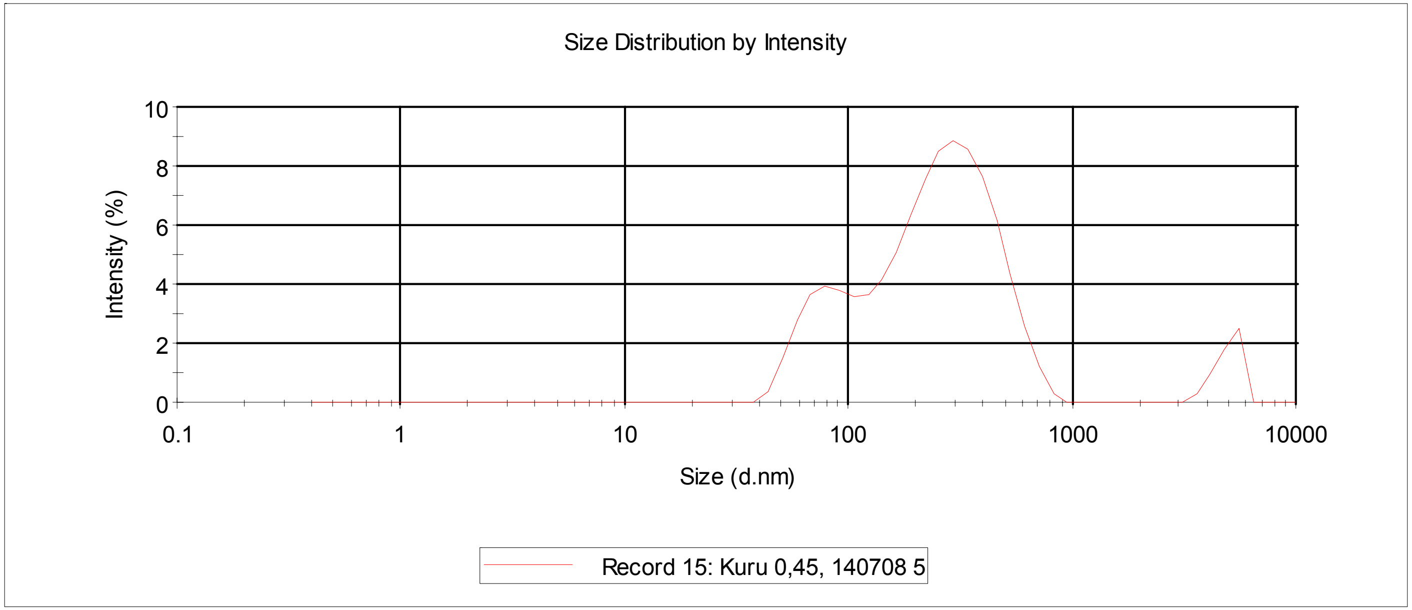
Z-Ave d.:

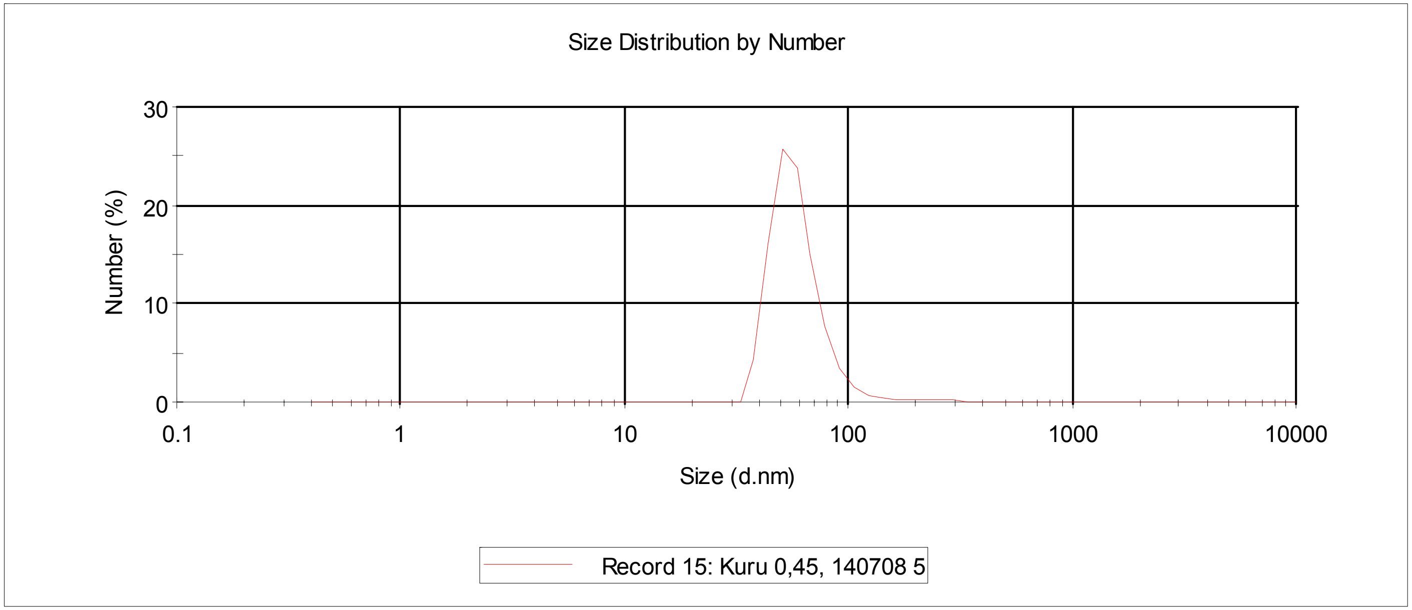
223 nm

Diameter:
60 nm

Zeta potential:

-26.6 mV





Syyry KR7 altered:

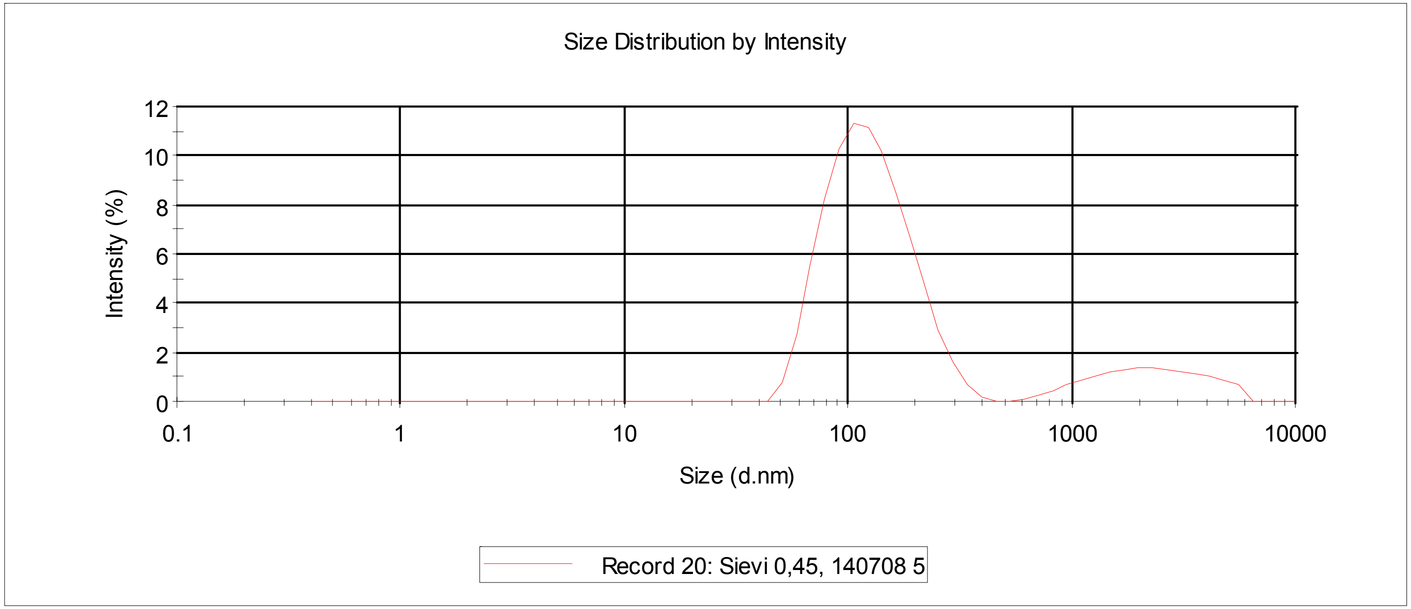
Z-Ave d.:

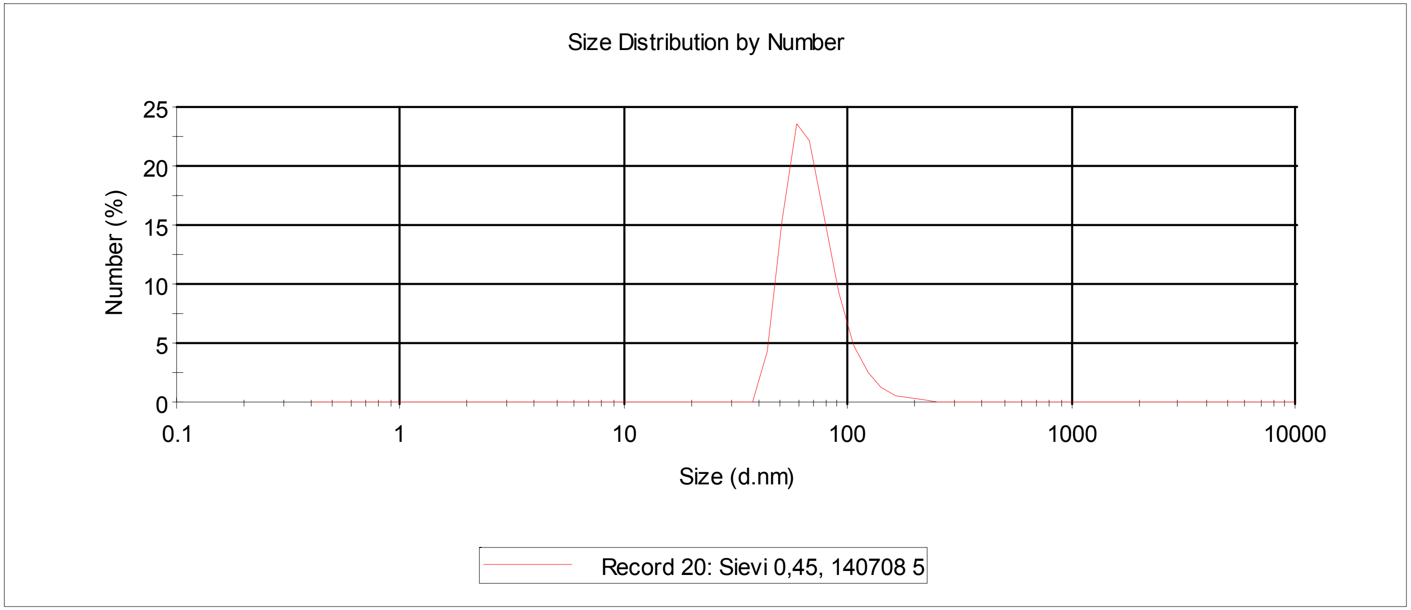
152 nm

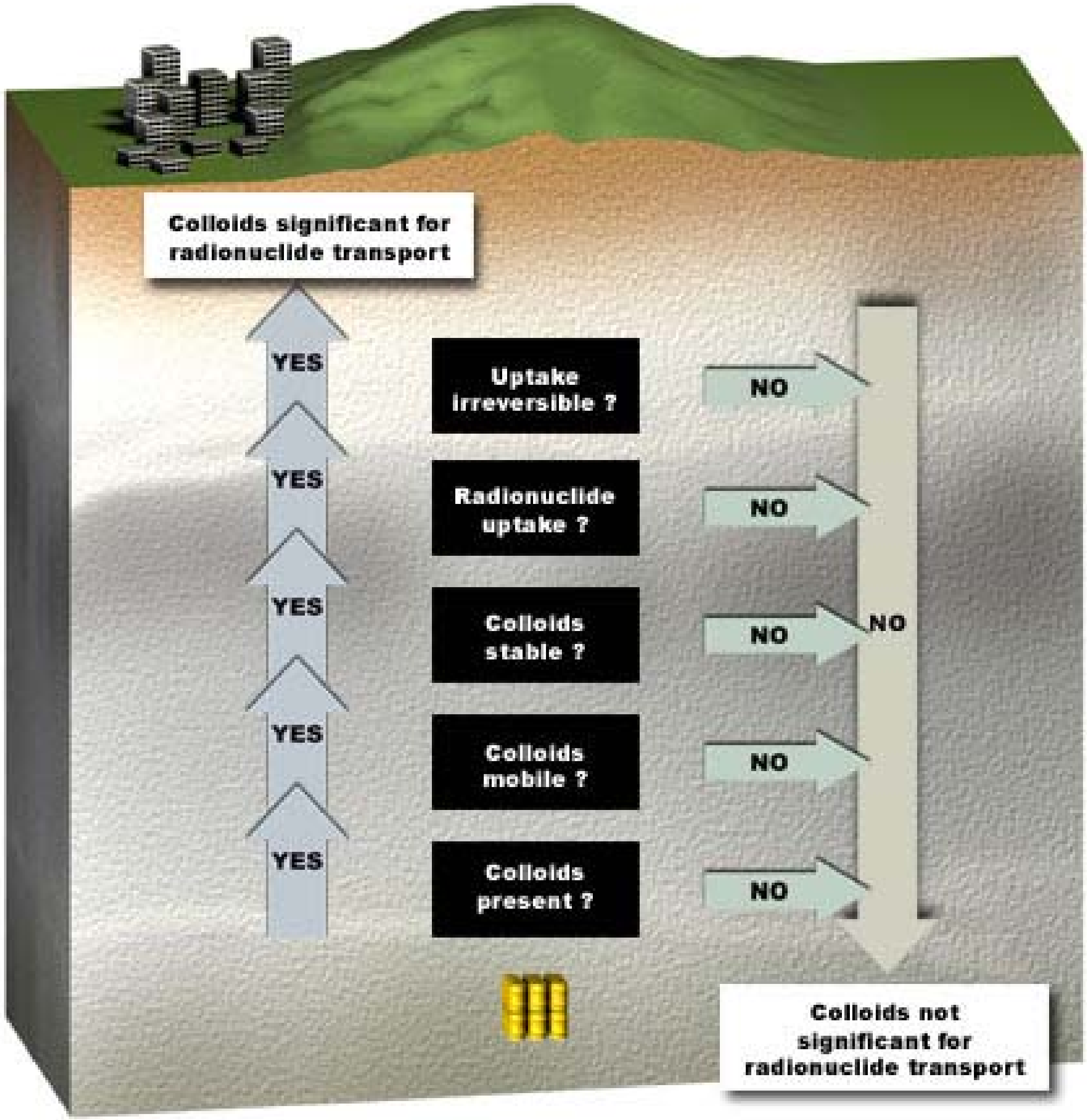
Diameter: 64.5 nm

Zeta potential:

-32.8 mV







http://www.grimsel.com/crr/crr_results.htm