The Interaction between FeS and DNA.

We have treated DNA with an iron(II) sulfide precipitate in an anoxic environment and investigated the interactions between the two using molecular biological techniques and direct observation by TEM. Chromosomal DNA incubated with 14mM or more of FeS loses its capacity to be amplified by the polymerase chain reaction and at concentrations of 25mM or higher can show a complete or partial reduction in concentration when viewed using ethidium bromide gel electrophoresis. Plasmid DNA was also incubated with FeS and ran on electrophoretic gels. This demonstrated a conversion from the covalently closed circular form to the open circular or linear form as well as a reduction in concentration and on occasions the appearance of an additional band implying the presence of a smaller DNA fragment.

Plasmid DNA was suspended on copper grids and rotary shadowed enabling individual molecules to be observed with a TEM. Tightly coiled DNA appeared to be less common when incubated with higher concentrations of FeS. Yaffee et al [1] observed iron(III) induced conformational changes to mtDNA using SEM and confirmed the presence of iron bound to the DNA which was the suggested mechanism of the alteration. However iron has not been detected bound to the DNA in this instance.

DNA conformational changes are usually ascribed to single and double strand breaks of the phosphate back-bone. Extensive breakages of this back-bone leading to severe fragmentation could explain the lack of appearance of DNA on gels. Highly fragmented DNA would also be unsuitable for PCR. Attacks on the phosphodiester bonds may be caused by highly reactive iron-sulfur clusters. A direct reaction with Fe^{2+} is unlikely as in all samples Fe^{2+} is at the same low concentration and thus cannot explain the variation seen with FeS concentration. Other researchers working in iron mediated DNA damage from a medical perspective have attributed it to the oxidation of Fe(II) to Fe(III) and the subsequent appearance of hydroxide radicals [2,3]. This is however unlikely in an anoxic sulfide system. Several researchers have theorized on the emergence of life in an iron sulfide environment [4,5]. Iron sulfide has been suggested to have the potential to be involved in the catalysis, metabolis m, containment and concentration (through adsorption) of organic precursors to biological molecules. A reaction between iron sulfide and nucleic acids may require a re-examination of iron sulfide origin of life theories to possibly include contemplation of some form of separation of the nucleic acid from the iron sulfide. Consideration should be given to bacteria and how some species have evolved the ability to compartmentalize the iron sulfide they produce in order to separate it from their DNA. Additionally this reaction has implications for the use of molecular techniques in microbial ecology of iron sulphide sediments as the alteration of DNA on extraction from sediments will introduce biases.

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2) Kawanishi, S., Hiraku, Y., Murata, M. & Oikawa, S. 2001. The role of metals in site-specific DNA damage with reference to carcinogenesis. Free Radical Biology & Medicine. **32**.(9) 822–832.

3) Toyokuni, S. & Sagripanti, J. 1992. Iron-Mediated DNA Damage: Sensitive Detection of DNA Strand Breakage Catalyzed by Iron. *Journal of Inorganic Biochemistry*, **47**, 241-248.

4)Wachtershauser, G. 1988. Before enzymes and templates: Theory of surface metabolism. *Mircobiological Reviews*. **52** No. 4 p 452-484.

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