Portland cement paste behavior under gamma radiation field in geological repository

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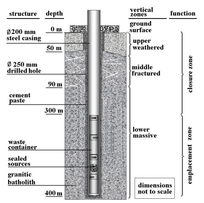
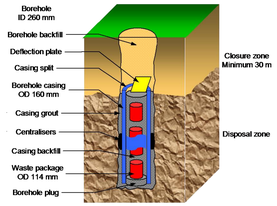
Deep borehole concept for disposal of disused sealed radioactive sources



IPEN Concept

Disused Radioactive Sealed Sources



BOSS Concept

Samples Preparation

Cubic Cement Paste Specimens (CPS) 1
HES cement + H_2O (W/C ratio = 0.35)

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Cement Hydration

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CPS storage or irradiation 3

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Samples removed from cps and grounded 2

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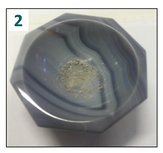
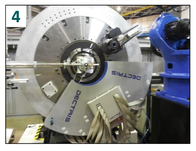
XRD Analysis 4
X-ray powder diffraction beamline
Brazilian Synchrotron Light Laboratory





Expected Output

A better understanding of the long term cement behavior under deep borehole repository environment, (e.g. durability and changes in its mineralogy and microstructure)

Expected Outcome

Improved safety assessment of the borehole repository in the long term

Disused Sealed Radioactive Sources (DSRS): a worldwide problem

DSRS: Storage and disposal problem in many countries over the world. Brazilian inventory is are about 300,000 sources in the inventory, many of them with high activity and long lived nuclides

Our proposal to deposition of DSRS

A repository for disposition of DSRS in a deep borehole, in which cement paste is intended to be used as a backfill between the steel casing and the geological formation around the borehole. The service life of this installation is thousands of years.

Issues to be addressed

Assessment of cement paste long term durability under borehole environment and its behavior under radiation, penetration of chemical aggressive species and high pressure and temperature.

Objectives

The objective of this work is to evaluate the changes in mineralogy and microstructure of irradiated cement paste specimens, in an attempt to establish a relationship between irradiation and durability

Methods

Cement paste specimens were casted and submitted to a gamma radiation field. The effect of doses between 1000 and 3000 kGy are evaluated by XRD to observe mineralogical changes

Results and Discussion

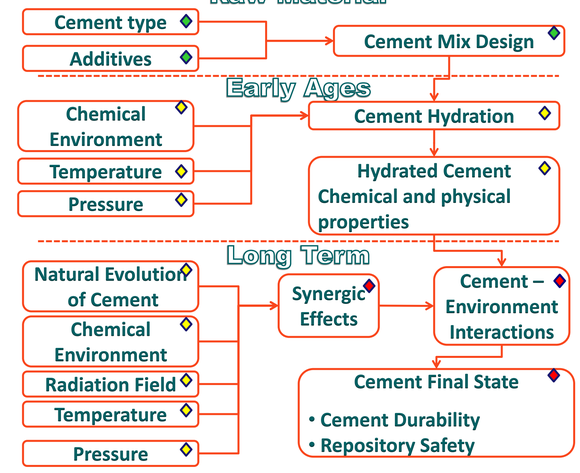
The results obtained at this work shows that cement paste mineralogy can be altered when this material is submitted to irradiation. It was observed that the portlandite was depleted and the calcium released reacted with carbonate to form calcite.

These reactions are higher in the surface of specimens because when formed, the calcite block the cement pores, and the carbonate species are not able to penetrate in the specimens anymore. In spite of portlandite can be depleted in the core of the specimens due to irradiation, the calcium was free to react with the water and reformate this mineral.

Conclusions

When submitted to a radiation field, cement paste mineralogy changes. These changes, in synergy with others factors present in the repository environment, can form deleterious species and decrease cement durability

Issues to be addressed



XRD Results – Differences between specimens submitted to different radiation doses