Prague, Czech Republic June 21-25, 2021

Contribution ID: **6** Type: **Poster**

#07-6 Monte Carlo calculations of the fluid and tubing effects on the gamma count rate of the NGRS probe

Thursday, June 24, 2021 5:15 PM (5 minutes)

Natural Gamma Ray Sonde (NGRS) is a gamma-ray logging probe used by ORANO Mining to estimate the uranium content in boreholes by detecting the gamma emissions of the ore. The total gamma count rate recorded with a NaI(Tl) scintillation detector is converted into uranium concentration using a calibration coefficient (in s-1.ppmu-1 units) estimated thanks to different calibration blocks in calibration facility operated by ORANO Mining in Bessines, France. The CEA Nuclear Measurement Laboratory has already performed Monte Carlo simulations with the MCNP computer code to estimate attenuation corrections in the ore (including self-absorption in uranium), in the filling fluids, and in the tubing. In this work, different tubing materials, diameters and thicknesses were simulated with an off-centre tubing. In the present new work, we have increased the number of diameters of the borehole and tubing, we have studied more tubing materials, and we have modelled a tube centred in the wellbore, instead of pressed on the wall, to be more representative of real measurements performed with a centring device. The MCNP model of the probe has been validated through a comparison with calibration experimental data: the calibration coefficient determined by simulation, 5.45 s-1.ppmu-1 with a 10 % uncertainty, is in good agreement with the one measured in Bessines 5.2 s-1.ppmu-1 (uncertainty not provided). The first parametric studies concerns the NGRS probe in a borehole without casing. They have been performed in a larger block than the calibration blocks located in Bessines (70 cm sides), in order to be more representative of a real measurement in an "infinite"ore medium. A small difference in the calibration coefficient is observed between a centered and off-centre probe for drilling hole diameters smaller than 200 mm, because gamma absorption by the drilling fluid is limited. However, for larger diameters, the calibration coefficient significantly decreases and the difference between the centred and off-centred probe positions increases, reaching more than a factor 3 for 800 mm diameter, with small differences depending on the filling fluid density. Then, the probe is simulated in a tubing centred inside the borehole. The calibration coefficients decrease as the borehole diameter increase, and when the density of the annular fluid (between the well wall and the outside of the casing) and drilling fluid in the casing increase. Finally, a probe located in the drilling pipe itself has been simulated, showing as previously that the calibration coefficient decreases with the increase of the rod diameter or with the density of the drilling fluid. This study required nearly 800 simulations carried out with CEA supercomputers.

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Session Classification: 07 Nuclear Fuel Cycle, Safeguards and Homeland Security

Track Classification: 07 Nuclear Fuel Cycle, Safeguards and Homeland Security