WEAR INDUCED MATERIAL MODIFICATIONS OF CEMENTED CARBIDE ROCK DRILL BUTTONS

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Abstract

The drill crown of a rock drill is made of steel and equipped with WC/Co cemented carbide buttons (or inserts) of different geometries. These rock drill button are exposed to a large number of high load impacts into the rock. The complex and strongly shifting properties of rock minerals lead to a complex mixture of wear mechanisms. These wear mechanisms have recently been mapped by the present authors, and are divided into five classes of deterioration and five classes of material removal mechanisms. In this paper, two important deterioration mechanisms are studied in detail, namely the binder phase degradation and the rock intermixing.

Transmission electron microscopy (TEM) has been employed for these high resolution studies. However, rock intermixture and huge internal stresses in the buttons lead to severe difficulties in preparing samples.

Therefore, a focused ion beam-instrument (FIB) has been used to cut cross section samples in the outermost surface on rock drill buttons. These have been investigated in the TEM by EDS, EFTEM, and STEM.

Buttons from two rock drills of different history were selected for this investigation. One was used to drill 18 m in a hard rock type (quartzitic granite) and the other to drill 20 m in a much softer rock type (magnetite). Only selected regions of the outermost WC grain layers, which are in a steady state wear mode, were investigated.

The crystallographic structure of the Co binder phase was investigated in both buttons, and it was represented mainly by the hcp-Co, but also small extent of fcc-Co. This is suggested to be a result of the mechanical fatigue, following one of two suggested Co-phase transformation series.

The rock covers and intermixed zones formed were analysed in detail. The large part of the rock cover was found to be amorphous, containing rock and WC fragments. Adjacent to the WC grains, the rock cover was often found to have a porous structure, where the pores were surrounded by crystalline Co-particles adjacent to a carbon rich area. Apparently, the quartz rock locally melts and sticks very intimately to the WC grains and the porous structure forms during solidification. This feature was further analysed, and it was shown that the amorphous rock is seamlessly connected to WC on the atomic level. It was also stated that the rock cover and intermixed layers are very similar on both buttons, independent of rock type drilled.