ABSTRACT

This thesis concerns extraterrestrial chromite (EC; $FeCr_2O_4$) which is a common accessory mineral in ordinary chondrites. Chromite is highly resistant to chemical erosion and weathering. Therefore, it is often the only surviving mineral of decomposed meteorites, making it useful for measuring the accretion rates of extraterrestrial material in ancient sediments. The studied mineral phase includes grains in the size range 63-355 μm, present as dispersed grains and *in situ* in the matrix of fossil meteorites found in Middle Ordovician limestone (~470 Ma).

The distribution of EC grains is shown across the upper Arenig and lowermost Llanvirn series of the Middle Ordovician epoch in limestone sections from six quarries located in the southern part of Sweden, covering an area of ~250 000 km^2. The distribution of "other Cr-rich spinels" (OC grains) are also investigated, which origin is not fully understood. However, the elemental composition suggests that a dominating part may be derived from mafic dykes exposed and weathered at the sea floor. The OC grains coexist with EC grains in some of the samples studied.

In the Thorsberg quarry a circa 3.2 m thick sequence of beds, previously shown to be rich in fossil meteorites, is also rich in EC grains. Typically 1-3 grains per kilogram of limestone were found. The recovered EC grains have a chemical composition very similar to the dominant type of chromite in equilibrated ordinary chondrites. The highest EC concentration was recorded in an interval called the Arkeologen bed. The subsequent searches in the five other quarries of the same stratigraphic interval show similarly high concentrations of extraterrestrial chromite grains.

The elemental composition of the analysed EC grains is very similar to the dominant type of chromite in equilibrated ordinary chondrites. In contrast to OC grains, which display a wide compositional range, EC grains can readily be distinguished by their homogeneous and characteristic major element chemistry, including 2.0-3.5 wt% TiO_2 and constant V_2O_3 concentrations close to 0.7 wt%. A detailed comparison of chromite compositions from fossil and recent meteorites shows that chromite in fossil meteorites can be used to discriminate these meteorites into petrographic grades on a scale from 3 to 6.

The onset of a two-orders-of-magnitude enrichment in EC grains close to the Arenig-Llanvirn boundary at the sites studied most likely reflects an increased flux of ordinary chondritic micrometeorites and meteorites to Earth. Considering lithologic and stratigraphic aspects variations in sedimentation rate cannot explain the dramatic increase in extraterrestrial chromite seen in the sequences at the six sites studied. Instead the increase in the ancient flux of extraterrestrial material to Earth at 470 Ma is likely connected to the disruption of the L chondrite parent body in the asteroid belt at about this time. Thus, the occurrence of EC grains in marine sediments can be used to trace events in space.

Finally, the results of the EC search in combination with a number of other constraints have been applied in a numerical model with the aim to calculate the delivery of ordinary L-chondritic meteorites to Earth after the disruption of the L-chondrite parent body. It is hypothesized that the fossil meteorites found in the Thorsberg quarry were transported to Earth in the immediate aftermath of the large collision in the inner asteroid belt that produced the Flora asteroid family.

Keywords: Chromite, chromium spinel, limestone, Middle Ordovician, Arenig-Llanvirn boundary, L chondrite, meteorite flux, fossil meteorites