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Barrier beach systems are some of the most dynamic among all coastal environments. Studies related to beach sediment sorting, transport and distribution are essential to understand their highly transient morphologies. This study presents an innovative application of environmental magnetic and sedimentological proxy parameters in combination with hydrodynamic modelling. The spatial distribution of magnetic minerals in beach sediments has been mapped and mechanisms controlling their distribution have been examined. About 90 surface sediment samples were collected seaward of a Holocene barrier beach (Matakana Island, Bay of Plenty, New Zealand) along four cross-shore profiles at depths of 4-25 m. Magnetic measurements on bulk sediment samples and sieved fractions showed that magnetic properties are dominated by MD magnetite and titanomagnetite. Magnetic mineral concentrations are highest in finest fractions and steadily decrease with larger particle sizes; <125μm fractions of the beach sediment are responsible for the majority of remanence. We hypothesize that selective settling and entrainment is primarily responsible for concentrating these magnetic and other heavy mineral grains within the finer fractions. Similar particle settling velocities of finer heavy and coarser light minerals within the investigated samples suggest that gravitational sorting played an important role. The spatial distributions of magnetic minerals showed that the concentration of magnetic minerals is high at the southern (Profiles 2 and 3) as compared to northern (Profile 1) ends of Matakana Beach. We also observed distinctive patterns of cross shore sorting with highly magnetic minerals and other dense mafic minerals enriching within the inner surf zone and lighter ones accumulating towards the seaward side. Sea bed orbital velocity calculations indicate that the zone of enhanced heavy mineral (magnetic and non-magnetic) concentration within the inner surf zone correlates well with a zone of rapidly increasing bed shear stress. The results clearly show that our integrated approach provides an effective method of characterizing the sediment distribution in a barrier beach system and can be applied elsewhere to investigate the sediment sorting processes along open coast beaches.