We have synthesized single crystals of a new rhombohedral ferrite using a flux method and carried out an X-ray crystal structure determination. The ferrite is isotypic with the B\textsuperscript{2} alumina with a chemical formula Na\textsubscript{3}K\textsubscript{x}Fe\textsubscript{3+x}O\textsubscript{11}O\textsubscript{17}. According to bond length-bond strength calculations, Zn\textsuperscript{2+} cations are positioned on the tetrahedral sites in the "spinel blocks". Ionic conductivity and magnetization measurements have been performed on single crystals. The (a,b) hexagonal plane is an easy magnetization plane; magnetocrystalline anisotropy constants have been determined.

A series of new compounds derived from this B\textsuperscript{2} ferrite has been obtained by ion exchange in molten salt, Li\textsuperscript{+}, Na\textsuperscript{+}, K\textsuperscript{+}, Ag\textsuperscript{+}, Ca\textsuperscript{2+}, Sr\textsuperscript{2+}, Ba\textsuperscript{2+}, Pb\textsuperscript{2+}, Pb\textsuperscript{2+} cations have been partially substituted for the large cations Na\textsuperscript{+} and K\textsuperscript{+}. These new ferrites have magnetic properties different from the former. All these compounds have been characterized using X-ray diffraction and scanning or transmission electron microscopy.

The crystal structure of the barium exchanged compound has been determined after annealing at 850°C. It is isotypic with the M barium ferrite. The refined chemical formula of the compound is Ba\textsubscript{3}Zn\textsubscript{1}Fe\textsubscript{11}O\textsubscript{17}. The easy magnetization direction is along the c axis for this compound. The magnetocrystalline anisotropy field has been determined.