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Observation of the spontaneous vortex phase in the weakly ferromagnetic superconductor $ErNi_2B_2C$: A penetration depth study EE MIN ELBERT CHIA, TUSON PARK, Los Alamos National Laboratory, MYRON SALAMON, University of Illinois at Urbana-Champaign, HEON-JUNG KIM, SUNG-IK LEE, Pohang University of Science and Technology — The coexistence of weak ferromagnetism and superconductivity in $ErNi_2B_2C$ suggests the possibility of a spontaneous vortex phase (SVP) in which vortices appear in the absence of an external field. We report evidence for the long-sought SVP from the in-plane magnetic penetration depth $\Delta\lambda(T)$ of high-quality single crystals of $ErNi_2B_2C$, using a high-precision tunnel-diode based, self-inductive technique at 21 MHz.. In addition to a slight depression of superconductivity at the Néel temperature $T_N = 6.0$ K and at the weak ferromagnetic onset at T_{WFM}=2.3 K, $\Delta\lambda(T)$ rises to a maximum at $T_m = 0.45$ K before dropping sharply down to $\sim$0.1 K. We assign the 0.45 K-maximum to the proliferation of spontaneous vortices. A model proposed by Koshelev and Vinokur explains the increasing $\Delta\lambda(T)$ as the vortex density increases, and its subsequent decrease below T_m as defect pinning suppresses vortex hopping.

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