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A novel two-dimensional (2D) coordination polymer with the formula Cr(pyrazine)\(_2\)(OSO\(_2\)CH\(_3\))\(_2\) has been synthesized and characterized. Powder X-ray diffraction data reveal that this material, which crystallizes in the Pnnm orthorhombic space group, is composed of rectangular grid layers with octahedral CrN\(_4\)O\(_2\) nodes bridged by pyrazine ligands. Since the redox-active pyrazine can be reduced in the presence of transition metals, X-ray absorption spectroscopy and quantum chemical calculations were used to confirm the +II oxidation state of the Cr center. Magnetic susceptibility measurements indicate the presence of antiferromagnetic interactions between the chromium(II) centers through the neutral pyrazine and suggest an antiferromagnetic ordered state below \(T_N \approx 10\) K, which was confirmed by heat-capacity measurements.