INTRODUCTION

Clinopyroxene containing up to 1.7 wt% of K₂O is a characteristic feature of certain inclusions in diamonds. Such K-rich clinopyroxene (hereafter Kcpx) inclusions (e.g., Bishop et al. 1978; Harlow and Veblen 1991) have also been encountered in some eclogitic and peridotitic xenoliths (Reid et al. 1976; Jaques et al. 1990). Until now, the maximum concentration of K₂O, 2.34 wt%, was reported for clinopyroxene megacrysts from a K-rich hawaiite from Australia (Ghorbani and Middleton 2000). However, experimental studies of model and natural systems at P > 5 GPa (Perchuk et al. 2002) have shown that 2.34 wt% is not a limit for the K₂O content in clinopyroxene. Chudinovskikh et al. (2001), Safonov et al. (2001, 2002), and Bindi et al. (2002), reported 5.50–5.75 wt% K₂O in clinopyroxene in the run products in both carbonate-silicate and aluminosilicate systems at 7 GPa.

Sobolev and Shatsky (1990) first described clinopyroxene containing up to 1.5 wt% K₂O as inclusions in garnets from fine-grained diamondiferous garnet-clinopyroxene rocks of the Kokchetav UHP Complex, Northern Kazakhstan. Similar clinopyroxene relics in garnet, containing up to 1.2 wt% K₂O, were studied in detail by Perchuk et al. (1995, 1996, 2002) and Perchuk and Yapaskurt (1998) in coarse-grained Grt-Cpx aluminosilicate rocks of the Kumdy-Kol microdiamond mine of the same complex. Thus far, the Kokchetav UHP rocks represent the only occurrence of K-bearing clinopyroxene (Kcpx) in a crustal environment. Kcpx of the Kokchetav Grt-Cpx carbonate-bearing and carbonate-free rocks differs in composition from Kcpx of kimberlites and lamproites. First of all, Kcpx from the Kokchetav rocks show wide variations of Mg no. from about 40 in Fe-rich Grt-Cpx rocks (e.g., Perchuk et al. 1996) to above 90 in Mg-rich Grt-Cpx rocks and dolomite marbles, whereas Mg no. of Kcpx from kimberlites and lamproites never falls below 70. In addition, clinopyroxenes of the mantle-derived rocks usually contain high concentrations of Na and Cr (e.g., Jaques et al. 1990; Harlow and Veblen 1991). The peculiar feature of Kcpx from Grt-Cpx rocks of the Kokchetav Complex is the very low concentration of Na (<1 wt% of Na₂O) and the absence of Cr. Moreover, K commonly dominates over Na in these Kcpx (Perchuk et al. 1996).

Here we report compositional and structural data on a unique Al-rich ultrapotassic (3.61 wt% K₂O) clinopyroxene, recently discovered in the Kokchetav rocks. The major purpose of the present study is to provide crystal-chemical characteristics of this clinopyroxene crystal, and to compare these data with those of Mg-rich Kcpx from kimberlites (Harlow 1996) and synthetic Kcpx (Bindi et al. 2002).

GEOLOGICAL SETTING AND PETROGRAPHY OF THE STUDIED ROCK SAMPLE

The Kumdy-Kol mine is situated in the Western part of the Kokchetav Complex (Lavrova et al. 1999). The geological position of Grt-Cpx rocks within the complex is thoroughly described in numerous books and papers (e.g., Dobrozhineckaya et al. 1994; Perchuk et al. 1995; Dobretsov et al. 1995; Shatsky et al. 1999; Lavrova et al. 1999). These rocks form interlayers, boudins, and lenses in garnet-biotite diamondiferous gneisses and schists metamorphosed under amphibolite-facies conditions. A metamorphic age of the host gneisses and schists is 524–535 Ma (Shatsky et al. 1999).

A representative sample of Fe-rich, diamond-free garnet-clinopyroxene rock of the Kumdy-Kol mine (Kum-39) was chosen for a detailed study of the Kcpx inclusions in garnets. The sample is a coarse-grained rock mainly composed of