Betpakdalite-CaCa $[Ca_2(H_2O)_{17}Ca(H_2O)_6][Mo^{6+}_8As^{5+}_2Fe^{3+}_3O_{36}(OH)]$

Crystal Data: Monoclinic. *Point Group*: 2/*m*. Crystals are short prismatic, with {hk0} and {h0l}, or pseudo-octahedra, to 0.2 mm; in crystalline aggregates, powdery, as thin coatings, massive. *Twinning*: Many crystals are "oriented intergrowths of two or three individuals."

Physical Properties: *Cleavage*: {001}, very good. Hardness = ~3 D(meas.) = 2.98-3.05 D(calc.) = 2.913

Optical Properties: Transparent. *Color*: Bright lemon-yellow with a pale greenish, rarely brownish, tint; greenish yellow in transmitted light. *Luster*: Dull to waxy. *Optical Class*: Biaxial (+). α = 1.782-1.809 β = 1.797-1.821 γ = 1.850-1.857 2V(meas.) = n.d. 2V(calc.) = 53°-88° *Pleochroism*: Distinct; *X* = pale yellow; *Y* = greenish yellow; *Z* = bluish green. *Orientation*: *Y* = *b*; *X* ∧ *c* = 12°. *Dispersion*: Inclined, extreme. *Absorption*: *Z* > Y > X.

Cell Data: *Space Group*: *C*2/*m*. *a* = 19.507(2) *b* = 11.0768(9) *c* = 15.2618(19) β = 131.488(5)° Z=2

X-ray Powder Pattern: Kara-Oba deposit, Kazakhstan.
8.75 (10), 3.63 (9), 1.532 (8), 1.480 (8), 2.95 (7), 1.732 (7), 1.191 (7)

Chemistry:

	(1)	(2)		(1)	(2)
MoO_3	50.24	53.15	CaO	4.14	4.48
As_2O_5	14.86	9.23	H_2O	19.00	[21.84]
Fe_2O_3	11.70	10.65	Total	99.94	100.01

(1) Kara-Oba deposit, Kazakhstan; wet chemical and DTA analyses. (2) Do.; normalized electron microprobe analysis, H_2O calculated, total includes Na_2O (0.25), K_2O (0.25), CuO (0.05), Al_2O_3 (0.02), SiO_2 (0.06), P_2O_5 (0.03); corresponds to $[(Ca_{0.74}Na_{0.17}K_{0.11})_{\Sigma=1.02}(H_2O)_{17.98}(Ca_{0.99}Cu^{2+}_{0.01})_{\Sigma=1.00}(H_2O)_6][Mo_8(As_{1.74}P_{0.04}Si_{0.02})_{\Sigma=1.80}(Fe^{3+}_{2.89}Al_{0.01})_{\Sigma=2.90}O_{32.44}(OH)_{4.56}]$.

Mineral Group: Betpakdalite supergroup, betpakdalite group.

Occurrence: Filling cracks in leached pyrite in the oxidized zone of a mineral deposit (Kara-Oba deposit, Kazakhstan); on vein quartz (Krupka, Czech Republic).

Association: Ferrimolybdite, gypsum, jarosite, hydromica, "limonite", "opal" (Kara-Oba deposit, Kazakhstan); molybdenite, molybdite, quartz (Krupka, Czech Republic).

Distribution: In the Kara-Oba Mo-W deposit, Bet-Pak-Dal Desert, central Kazakhstan. Well characterized material from the Descubridora mine, Pampa Larga district, Copiapó, Chile; at Bajan Cogto, Mongolia; from the Rustler mine, Gold Hill district, Tooele County, Utah, USA; and the Nedre Kvartsen quarry, Drag, Tysfjord, Nordland, Norway. At Krupka, Krušné hory Mountains, Czech Republic. From Vaulry, Haute-Vienne, France. At Tsumeb, Namibia. From Elsmore, New South Wales, Australia.

Name: For the original occurrence in the Bet-Pak-Dal Desert, Kazakhstan. Two suffixes correspond to the dominant cations in the two different types of non-framework cation sites.

Type Material: A.E. Fersman Mineralogical Museum, Moscow, Russia, 62532, 62533.

References: (1) Yermilova, L.P. and V.M. Senderova (1961) Betpakdalite – a new mineral from the oxidation zone of the Karaoba wolframite deposit. Zap. Vses. Mineral. Obshch., 90, 425-430 (in Russian). (2) (1962) Amer. Mineral., 47, 172-173 (abs. ref. 1). (3) Čech, F. (1962) The yellow molybdic ochre from Krupka in the Krusne Mountains. Casopis Mineral. Geol. 7, 195-197. (4) (1962) Chem. Abs., 57, 3093-3094 (abs. ref. 3). (5) Kampf, A.R., S.J. Mills, M.S. Rumsey, M. Dini, W.D. Birch, J. Spratt, J.J. Pluth, I.M. Steele, R.A. Jenkins, and W.W. Pinch (2012) The heteropolymolybdate family: structural relations, nomenclature scheme and new species. Mineral. Mag., 76(5), 1175-1207.