

Gems & Gemology Data Depository

Supplementary photos to accompany: M. H. Smith and W. A. Balmer, "Gem News International: Cambodian zircon mining," Summer 2009 *G&G*, pp. 152–153.



Figure 1. A panoramic view of the area south of Phum Thmei, some 15 km southeast of Ban Lung. Much of the area has been recently cleared for planting cashew trees. The hand mining area of Bo Kalap is approximately 1 km east (left) of the car. Photo by W. A. Balmer.



Figure 2. Approaching the zircon mining area of Bo Kalap. The hand mining area is beside the small stream (a tent is visible on the left). The area mined with machinery by Ultra Marine Kiri (Cambodia) Ltd. is almost straight ahead on the slope of the gentle hill. Photo by W. A. Balmer.



Figure 3. The trommel, jigs, and now vacant mining camp of Ultra Marine Kiri (Cambodia) Ltd. The hand mining area of Bo Kalap is behind the trees on the right side of the picture about 200 m away. Photo by W. A. Balmer.



Figure 4. A miner at Bo Kalap shows the yield of one day's hand mining for zircon. Photo by M. H. Smith.



Figure 5. Shafts at Bo Kalap are generally only 2-3 meters deep. The ground consists of volcanic pyroclastics (lapilli [2-64 mm] and volcanic bombs [>64 mm]) and requires washing, in this case with pumped water, to remove the clay before screening to recover the zircon. Photo by W. A. Balmer.



Figure 6. At Bo Kalap, after removing much of the clay by blasting the excavated dirt with pumped water, the remaining gravel is carried to a nearby stream for screening. Photo by M. H. Smith.



Figure 7. A miner at Bo Kalap examining a zircon he has just found. Photo by M. H. Smith.



Figure 8. Four pieces of opaque blue trapiche and black star sapphire together with one small pyrope garnet found at Bo Kalap. More than 95% of the gems found here are brown zircon; other gems such as these are quite uncommon. Photo by W. A. Balmer.



Figure 9. Basaltic rock formation at Bo Kalap presenting cooling structures (upper left) and exfoliation textures (right). Photo by W. A. Balmer.



Figure 10. Low-quality rough zircon from Bo Kalap. While most stones are less than 1 g, this parcel included several pieces up to 25 g. Photo by W. A. Balmer.



Figure 11. Panoramic view of the current mining area at Bo Keo. There were approximately 30 shafts being worked here in April 2009. Photo by W. A. Balmer.



Figure 12. Each shaft at Bo Keo is worked by 2-4 people. Shafts are typically 15 m deep. Photo by W. A. Balmer.



Figure 13. Shafts at Bo Keo are round and typically 80-100 cm in diameter. No rope or ladder is used to descend or ascend. Instead notches for hands, elbows, and feet are cut into the soil.(Photo by M. H. Smith.



Figure 14. At Bo Keo the basalt which carried the zircon to the surface has weathered to soft red soil known as laterite, and the only hard minerals remaining are the resistant gems. Thus the soil here does not need to be washed. It is brought to the surface and the miners sort through it by hand, feeling for hard stones, which are almost certain to be zircon. Photo by W. A. Balmer.



Figure 15. The next generation of zircon miners play in a shallow shaft at Bo Keo. Photo by W. A. Balmer.



Figure 16. The village of Bei Srok, about 17 km southeast of Ban Lung, experienced a zircon rush in 2001. Photo by W. A. Balmer.



Figure 17. At Bei Srok there are some active mining shafts amongst the village houses. Depth to the zircon bearing layer is approximately 10 m. As at Bo Keo, the zircon-bearing basalt has weathered to soft red soil and gems are recovered by hand without washing. Photo by W. A. Balmer.



Figure 18. Approximately 10 kg of zircon rough at Bei Srok. Photo by W. A. Balmer.



Figure 19. Half of Bei Srok's junior soccer team on one motorcycle. Photo by W. A. Balmer.



Figure 20. Half a kilometer west of Bei Srok village is a large area with hundreds of abandoned mines, reminiscent of Ilakaka, Madagascar. Photo by M. H. Smith.



Figure 21. The road from Kes Chong to the mining area near Bo Loy village passes through some beautiful forest. Photo by M. H. Smith.



Figure 22. Deforestation is rampant all over Ratanakiri Province, as here near Bo Loy village, a zircon mining area about 23 km northeast of Ban Lung. Photo by W. A. Balmer.



Figure 23. Bo Ga-nat, 4 km northwest of Bo Loy, is a small mining camp in the middle of the jungle. We were told that 40 families were mining in this area. The impact of zircon mining on the forest was minor when compared with the deforestation taking place elsewhere in the area. Here at Bo Ga-nat zircon mining is done carefully and people still live in harmony with their environment. Photo by W. A. Balmer.



Figure 24. A miner at Bo Ga-nat offers zircon rough for sale. Photo by W. A. Balmer.



Figure 25. At Bo Ga-nat the zircon deposit is cut by a stream. The gravels of the stream are mined and nearby shafts are sunk to depths of up to 8 m. The zircon-bearing ground here is very rocky and requires screening and washing to separate the gems. Photo by M. H. Smith.



Figure 26. A miner emerging from a shaft at Bo Ga-nat. Photo by W. A. Balmer.



Figure 27. At Bo Ga-nat the ground is hard and rocky. Shafts are square and footholds are cut into the sides for access. Photo by M. H. Smith.

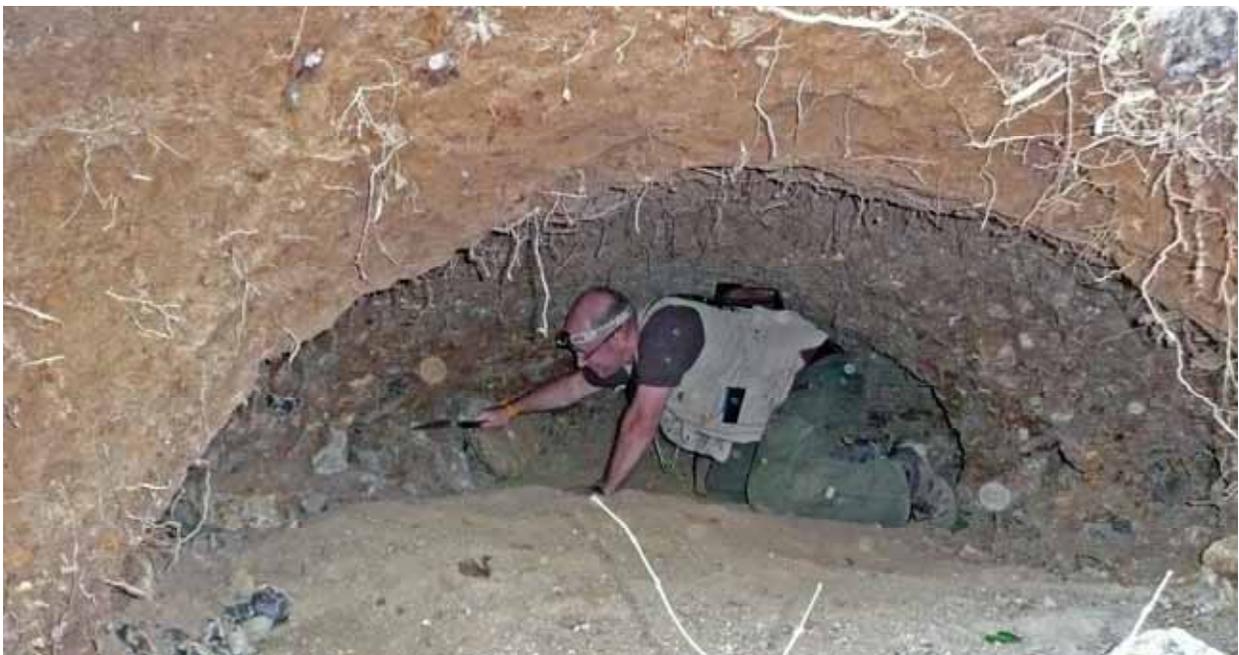


Figure 28. Walter Balmer examines a drift dug into a stream-cut bank at Bo Ga-nat. The ground consists almost entirely of basalt cobbles of various sizes. Photo by W. A. Balmer.



Figure 29. Gems found at Bo Ga-nat. The majority are brown zircon while the nearly black material in the upper left is low grade, mostly opaque, corundum. Additionally, there were a few small pieces of transparent feldspar. Photo by W. A. Balmer.



Figure 30. A homemade miners lamp and the day's production of zircon at a mine in Bo Ga-nat. Photo by M. H. Smith.



Figure 31. Bo Loy village is home to miners and farmers of the Tampuan ethnic group. There are a number of past and present zircon mining areas within a few kilometers of this village. Photo by W. A. Balmer.



Figure 32. Brown zircon is packed into a ceramic crucible prior to heating. Nothing else is added in the process. Photo by M. H. Smith.



Figure 33. The first crucible is cemented with fire clay and sealed into a larger outer crucible to exclude oxygen during the heating. Photo by M. H. Smith.



Figure 34. The crucible is loaded into an oven atop 60 cm of hardwood charcoal. Photo by W. A. Balmer.



Figure 35. After loading the crucible atop the charcoal, a fan is placed in front of the oven opening to accelerate the ignition process. When sparks start shooting out the top, working temperature has been reached and the cone is inserted to connect the chimney to the oven. Photo by W. A. Balmer.



Figure 36. After 1–1.5 hours of heating in the charcoal oven at $\sim 900\text{--}1000^\circ\text{C}$, the crucible is removed, cooled briefly, and opened. Photo by W. A. Balmer.



Figure 37. Ratanakiri zircon before and after simple heat treatment. Sizes range from 1 ct to almost 120 ct. Many stones show remnants of the tetragonal crystal shape, and many have a smooth shiny surface as a result of resorption during transport by basalt. Photo by Prasit Prachagool, Thai Lanka Trading Ltd.



Figure 38. Preforming small heated blue zircons in Ban Lung. While most rough is sent to Phnom Penh and Chanthaburi, there is a small cutting industry in Ban Lung. Photo by W. A. Balmer.



Figure 39. The fresh market at Ban Lung, Ratanakiri Province. Photo by W. A. Balmer.



Figure 40. An open-air jewelry store and money changer in the market at Ban Lung, capital of Ratanakiri Province. Photo by M. H. Smith.



Figure 41. Downtown Ban Lung, Ratanakiri Province. Photo by M. H. Smith.



Figure 42. Three kilometers southeast of Ban Lung is Yak Lom Lake, a volcanic structure known as a maar that was created by the destructive powers of a massive explosion that left a crater ~1 km in diameter. Yak Lom Lake is a graphic illustration of the volcanism which brought the Ratanakiri zircon to the surface, allowing us to enjoy the beauty of this sparkling gem. Photo by W. A. Balmer.