

Gold recovery in wooden trays in Russia - the term 'lotoking'

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About the author



Robin graduated in Geology and Zoology from Manchester University in 1970 where he completed a Masters Degree in Geology before lecturing at Wigan Mining College for ten years. Robin is a specialist in placer gold and ecology and is currently compiling Best Available Techniques (BAT) for Placer Gold Miners. He is Stepegold on the famous Alaska Gold Forum (<http://bb.bbboy.net/alaskagoldforum>).



Purpose of study

The article sets out to clarify the special character of a lotok and why it remains so popular among geologists, mining engineers and placer mining companies inside the former Soviet Union and Mongolia, and why the lotok has been so comprehensively rejected by nearly all of Mongolia's artisanal miners.

The operation of the lotok is described and illustrated and the term 'lotoking' introduced to distinguish the operation from pans.

The lotok is distinctive in being a unique combination of 2 inclined trays joined together in a gentle v-shape.

The operation of the lotok is distinctive and indicates the device is related to thin-film separators such as tables, shaking tables, belts and vanners. Part of the lotok movement is difficult to relate to any other gravitational devices.

The lotok has remain little changed for more than 70 years and continues to play a central role in placer mines, gold rooms, placer drilling sites and heavy mineral prospecting throughout the former Soviet Union and Mongolia. The continuing success of the lotok is attributed to it being ideal for industrial scale upgrading of concentrate in combination with a water bath.

No technical account of the lotok appears to have been published previously. The author is unaware of any scientific tests on the percentage gold recovery of lotoks having been published in any language. It remains unclear if the lotok is more efficient at recovering fine gold and flat gold than is a pan, batea, dulang, ninja bowl, trinity bowl, grizzly pan, mat, bucket or any other sort of hand-driven gravitational device.

Figure 1.

ABOVE – recovering gold with a lotok in a bath. Notice the ease of use due to the oblong shape of the lotok, and the manner in which half its length rests floating on the water. Drilling site of Khos Khaas Ltd in the Zaamar Goldfield. (photo: Robin Grayson)

BELOW – the lotok is often carved from a single piece of wood. The rough grain of the wood assists trapping the gold. (photo: Tsevel Delgertsoo of Ochir LG Ltd.)

What is a lotok?

Lotoks belong to the diverse group of gravitational gold recovery devices that are driven directly by hand without handles, gears or other mechanical means [1,2].

This group includes not only the classic gold pan [3,4] and lotok but also the bowl-shaped batea [2] of South-Central America, conical dulang [5] of South-East Asia, ninja bowl of Mongolia [6], rubber mat of Mongolia [7], bucket of Kyrgyzstan [8] and other traditional devices, as well as hand-held innovations in North America such as Le Trap pan [9], grizzly pan [10], and trinity bowl [11].

The lotok consists of a pair of flat trays gently tilted in a shallow v-shape along the crease where they meet (see figure 3). In this manner one end of each tray abuts the other tray, and the pair of trays is permanently fixed together by gluing, screwing or welding – or by virtue of being made from a single piece of wood which is the most prevalent method of manufacture. Most of the illustrations are of lotoks with paired trays made from a single piece of wood as illustrated by the grain in figure 1. A metal lotok with paired trays welded together is shown in figure 22. The opposite end of each tray ends abruptly in a straight edge that serves as a weir across which water and sediment enters or leaves the tray depending on the hand action of the operator. The left and right sides of one tray are contiguous with the left and right sides of the opposing tray, and raised as inwardly sloping walls to deflect back onto the trays any water or sediment that attempts to escape by slopping over the sides. The sidewalls are highest adjacent to the v-suture between the two trays and each sidewall tapers gradually to zero at the far end of each tray (see figures 2 and 3).

It should be apparent from the description and illustrations that the lotok has no obvious morphological affinity with pans, batea, bowls, dulangs, buckets or mats. Radically different in shape from one another, these devices are classed together only because they are all gravitational devices for recovering heavy minerals that are controlled solely and directly by hand movements.

Lotok history and origin

The author has not researched the origin of the lotok, nor is there an obvious starting point for its origin and development – unlike the clear origins of the western pan, Mongolian bowl and Kyrgyz bucket. ‘Lotok’ (= lotke) is a Russian word meaning tray, a tray of no particular type. In a geological dictionary [12], *lotok promivochne* = panning dish.

The lotok is customarily made of wood, and indeed often carved out of a single piece. This might suggest great antiquity before the industrial manufacture and wide distribution of frying pans and other metal goods. Indeed the lotok is radically unlike any modern item known to the author, so it may have arisen suddenly by a pan-less miner pressing into service a device then in common use for a completely different purpose now lost in history.

Less plausibly, the lotok may have been designed from first principles, by a miner with only wood available.

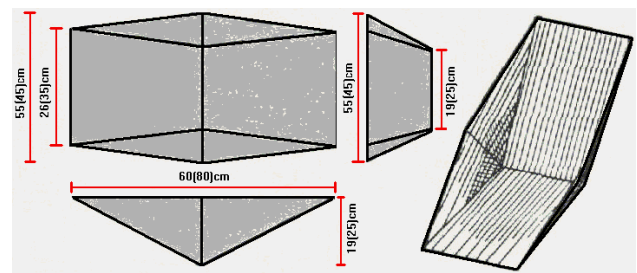


Figure 2. Sketch of a traditional lotok. (drawing; Robin Grayson)



Figure 3. A lotok held steady with its v-depression horizontal and both the trays inclined towards it. This lotok has recently been cleaned by firing it. (photo: Robin Grayson)

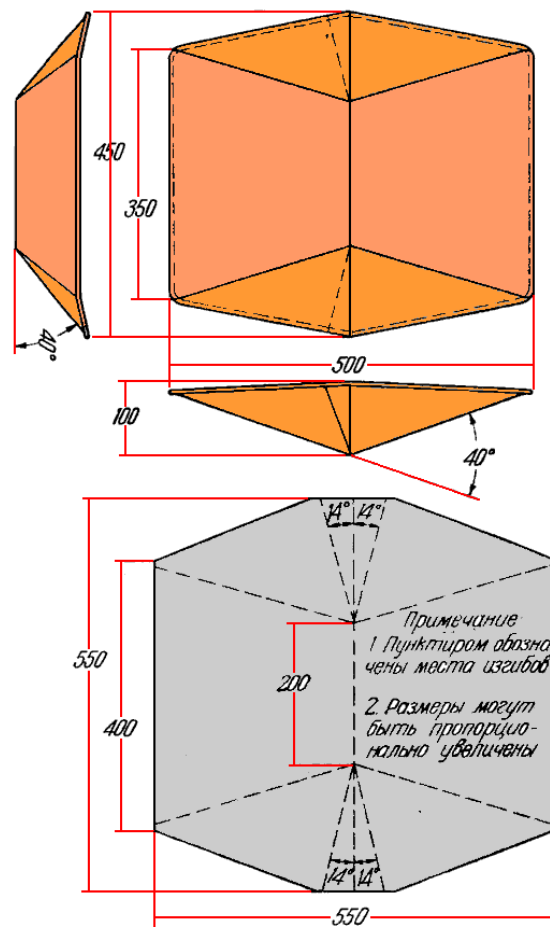


Figure 4. A set of lotok drawings of 1935 by P.A. Kharitonov, *Soviet zolotopromyshlennost* [4]. Modern lotoks are not much different. (redrawn: Robin Grayson)

Lotoking – a proposed new term

The author proposes the technical term 'lotoking' in order to permit a narrow technical description of the process of using a lotok for recovery of heavy minerals (gold, platinum, tin, diamonds, gems etc.). It doing so, it removes confusion with North American pans when the broad term 'panning' is used.

The term 'panning' retains merit as an everyday expression for all manner of washing devices that are directly driven by hand movements; but it is counterproductive in technical assessment of devices as diverse as the hand-driven pan, lotok, batea, dulang, bucket, ribbed mat and washing-up bowl.

Lotok – uptake by geologists and placer mining companies

Whatever its origin, long before the 1930s the lotok had become the 'device of choice' for manual recovery of gold by geologists and mining engineers throughout the Soviet Union and Mongolia. Indeed the author has observed in the Russian Federation (Bashkeria Republic), Kazakhstan, Kyrgyzstan and Mongolia that the lotok is virtually the symbol of office of placer geologists and placer mine engineers. The author has observed lotoks being the favourite device for heavy mineral prospecting along streams, recovering placer gold from churn drills and bucket drills and as a step in cleaning gold concentrate from bucket line dredges and sluices.

Lotok – rejected by ASM

In spite of the overwhelming popularity of the lotok shared by geologists, mining engineers, drill crews and gold room "panners", the lotok failed to find favour among the illegal artisanal and small scale miners (ASM) of Mongolia. The first wave of ASM began in depressed mining communities [13] so it was natural for lotoks to be used alongside metal bowls and rubber mats (see figure 7). But green plastic bowls swiftly replaced both metal bowls and lotoks. It might be thought that green bowls are cheaper, but lotoks can be home-made from timber and there are dense forests in north-central Mongolia. The author notes that plastic bowls seem to get irreparably damaged after a few weeks of intensive use and have to be replaced whereas lotoks are more durable.

Empowered by USA drywasher technology, ASM has spread throughout the vast Gobi Desert where trees are sparse and arguably unsuitable for making lotoks. It seems likely that the majority of ASM in Mongolia have never seen a lotok and would not know what it was used for if one was presented to them.



Figure 5. Provision of water baths allows lotok operators to maintain an upright posture. The water is kept warm by a wood-burning fire under the tank. Smoke is removed by the chimney pipe. Bugant Mine in north Mongolia. (photo: Gerrit Bazuin of Ochir LG Ltd)



Figure 6. For prospecting, water baths are cut to the minimum size and the lotok according narrow. Warm water can be added from a kettle. The operator sits on a tiny stool. Altanzul of Eco-Minex is showing how to do it. (photo: Dr. Baatar Tumenbayar)



Figure 7. Artisanal miners using lotoks directly in a pond, without a water bath. The woman on the right cannot sustain her tightly arched crouched posture for sufficiently long to generate much income. Boroo in north Mongolia. (photo: Gerrit Bazuin of Ochir LG Ltd)

Lotok – why retained by geologists and placer mining companies

The author assumed that the rejection of the lotok by ASM heralded a similar rejection by the formal sector in favour of plastic bowls. It did not happen and shows no sign of happening. This was perplexing and the author inclined to the view the unchallenged persistence of the lotok as technological conservatism of soviet-trained geologists and placer companies, or that the green bowl had become so identified with ASM that the formal sector sought to avoid such an emblem.

While such factors may contribute to the unwavering popularity of the lotok, the author believes that the main reason is that the lotok – not the green bowl – is better suited to gold room operations as a process step in upgrading concentrate. The lotok fits snugly into a water bath (figure 6) whereas a bowl cannot. The contents of the lotok are more visible to surveillance by the operator and security staff. As gold rooms and drilling sites have water baths and piped water supply then the inability of a lotok to carry water is not a handicap; likewise the lotok stays put and the problem of carrying it does not arise.

Interestingly green bowls are seen in many gold rooms and drilling sites, but used only for holding gravel or water and are kept out of the gold recovery system. This suggests the lotok, by analogy with business, is a niche player that fulfils a precise processing step better than the bowl. In contrast the bowl is a generalist, best at conducting the entire process – carrying placer, carrying water, storing water, manual screening to reject washed oversize, manual searching for nuggets, and mineral separation to produce a reasonably clean concentrate.

If this assessment of the lotok is correct, then the status quo may persist *ad finitum* – the lotok is superior in satisfying a specific process step in gold recovery or mined ore and drill samples, while the bowl is superior as a multifunctional device required by ASM.

This elegant theory is marred somewhat as the lotok remains the favourite of geologists in prospecting. The author suggests the lotok persists as the professional symbol of a geologist's status, as well as inertia – *“it works for us, we trust it so why change it?”*

Lotok – why rejected by ASM?

The reasons why the lotok was rejected by ASM, and so completely, are not simple. From anecdotal evidence and limited observation the author suggests that the abrupt demise of the lotok in favour of the green ‘ninja’ bowl was a permutation of many factors. In essence the lotok is more difficult to carry, achieves less gold production per day, and is quite impractical for carrying gravel or water. Furthermore the shape of the lotok is not conducive to retaining much water, even if the device is propped to keep the v-shape upright. Therefore for continuous operation the lotok has to be kept in a stream, pond or water bath or the process halts. In contrast a bowl continues to operate even when lifted out of the water, allowing the operator to have a more varied less tiring posture, and rendering a water bath redundant.

factor	lotok	green bowl
weight	rather heavy	light
ease of transport	under arm only	easy on back
carrying gravel	poor	excellent
carrying water	no	very good
retaining water	very poor	very good
hand screening	moderately good	very good
concentrating	very good	good
water currents	significant problem	perhaps advantageous
small waves	significant problem	not a problem
with water bath	ideal shape	very clumsy shape
surveillance	very easy	not so easy
processing speed	rather slow	rapid
% gold recovery	very good	arguably less good
gold per day	moderate	higher
other uses	none	many domestic uses
availability	among miners	every general store
home-made	possible	impossible
factory-made	occasional	millions produced
longevity	years	weeks to months
Retail price	20-50 USD	4 - 5 USD
skill required	moderate to high	low to moderate

Figure 8. Comparison of the advantages and disadvantages of the lotok compared to the green ‘ninja’ bowl.

factor	North American gold pan	Soviet lotok
weight	light	rather heavy
ease of transport	hand or under arm	under arm only
carrying gravel	poor - moderate	poor
carrying water	poor - moderate	no
retaining water	very good	very poor
hand screening	moderately good	moderately good
concentrating	very good	very good
water currents	perhaps advantageous	significant problem
small waves	not a problem	significant problem
with water bath	OK, but not ideal	ideal shape
surveillance	fairly easy	very easy
processing speed	rather slow	rather slow
% gold recovery	very good	very good
gold per day	moderate	moderate
other uses	frying-pan	none
availability	among miners	among miners
home-made	from a frying pan	possible
factory-made	special companies	occasional
longevity	years	years
Retail price	5 - 20 USD	20-50 USD
skill required	low to high	moderate to high

Figure 9. Comparison of the advantages and disadvantages of the lotok compared to the North American gold pan.

Style of operation

Posture of the operator

Apart from being made from local timber, the traditional wooden lotok has the advantage of floating. The device is supported by water when used by the operator either squatting by the water's edge or when standing or sitting by a water bath in a gold room or drill site. A lotok should also function well while the operator stands in a metre of water, but the author has yet to observe this, as all mine and drill sites are properly equipped with water baths, and ASM rarely use the lotok. In any case the distribution of the lotok approximates to the cold northern forests where standing in a metre of cold water would invite hypothermia unless expensive and cumbersome protective clothing were worn. On the other hand, the lotok could be ideally suited to the needs of ASM in warm climates where standing in warm water may be congenial for a few hours.

Prior to operation

Prior to use, the lotok is inspected for cleanliness and any surface grease or oil. It is customary to occasionally scorch the interior of the lotok with a flame in order to remove dirt and create a new surface albeit at the risk of introducing oil and grease if the light is from a candle or oil lamp. Some operators scrub the lotok with a stiff brush or sandpaper, others do not. In general it is considered helpful if the grain of the wood stands slightly proud of the surface as a rough texture supposedly assists in trapping small particles of dense minerals.

The final ritual is to ensure that the lotok is thoroughly wetted prior to use. This helps identify any area of oil and grease so enabling it to be eliminated. It also encourages dry materials being washed to make proper contact with the surface of the lotok.

Holding the lotok

The lotok is placed on the surface of the calm static water, while holding it at one end by both hands; the left hand grasping the left corner and the right hand grasping the right corner. The operator should be sitting or standing in a comfortable posture, not only to prevent tiredness but also to ensure that he/she can operate the lotok with precision for a lengthy period.

A water bath is highly desirable. If indoors in a gold room or drilling cabin then a water bath can be specially constructed. If outdoors of necessity or by choice, then the water bath can indeed be – and often is – an old enamelled iron bath. Such baths are remarkably heavy and in being moved only with difficulty are best suited to semi-permanent mine camps or next to a static wash-plant. For prospecting it is impracticable to haul an iron bath with the team. Eco-Minex uses a trough of sheet metal wide enough to just accommodate a narrow lotok (figure 21). This also minimises the water requirement. The bath unit is raised on short legs, sufficient for the operator to sit on a small stool with comfort.



Figure 10.

A comfortable posture is essential. Nick Grayson tries lotoking, sat on a stool beside an old enamel bath at the Berleg Mine in north Mongolia. (photo: Robin Grayson)



Figure 11.

Close-up of a wooden lotok being used by an informal placer miner in Mongolia. (photo: Minjin Batbayar)

Water movement

Static calm water needs to be available in order for a lotok to operate properly and smoothly, according to lotok operators questioned recently by the author. This is in line with the opinion expressed 70 years ago by Soviet placer geologist P.A. Kharitonov [13].

To ensure static calm water, water baths are widely used.

Understanding quite why a lotok demands static calm water sheds light on how a lotok differs its it gold concentrating method from that of pans, bowls, buckets, bateas, dulangs and mats – all these devices can function with varying degrees of efficiency in strongly flowing water with small choppy waves.

Controlling water inflow and outflow

Water inflow and outflow is limited to the lip of the lotok tray furthest from the operator. By gently pressing down with the hands the lip is raised to form a watertight dam; by gently pulling up with the hands the lip is submerged and ceases to be a dam and becomes a weir.

Tailings discharge

By slightly raising the hands, the furthest tray of the lotok rotates downwards, triggering an outflow of 'dirty' water with suspended tailings. Raising the hands fractionally more may release a plume of tailings including light sands.

Supply of wash-water

Supply of wash-water into the device is solely via the far end of the furthest tray of the lotok. By depressing the hands the lip of the tray ceases to be a dam and becomes a weir. Often wash-water will spontaneously override the weir and enter the lotok as an inrush behind a discrete solitary advancing wave-front. The inrush is very shallow, typically only a few millimetres deep. The operator may decide to increase the depth, duration and power of the influx by not only depressing the hands but also by shoving the lotok slightly forward. This action causes the lip of the lotok to slice off a thin layer of surface water and it enters the device.

Controlling water level

The water level inside the lotok is controlled by the operator in the following manner. The water level is maintained by ensuring that the lip of the far tray is kept up so as to be a water-tight dam.

By tilting the lotok the dam is lowered and tailings may be discharged from the device OR new wash water may enter. Some training and experience is required to manage the inflow and outflow in terms of duration, depth and velocity to maintain any desired water depth inside the lotok.

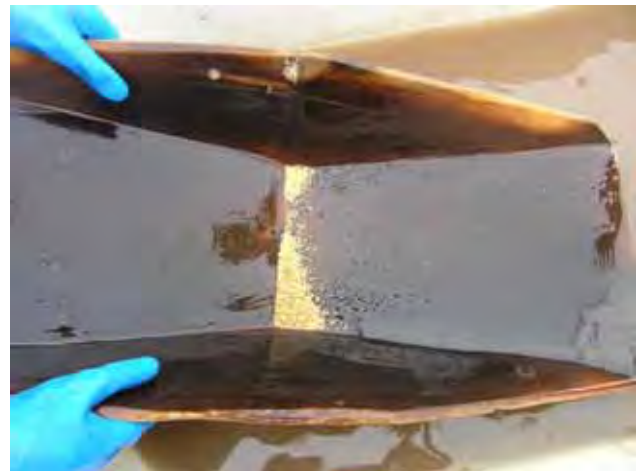


Figure 12.

A skilled operator is able to make full use of gentle flows, not only in-and-out but side-to-side. (photo: Robin Grayson)



Figure 13.

An assistant removing magnetic from a lotok at the Berleg Mine. (photo: Robin Grayson)



Figure 14.

A water bath inside the gold room of the Sharin Gol mine of Polymet Potala Ltd. Note the submerged enamelled dish to catch the tailings for later checking. (photo: Robin Grayson)

Upgrading by flushing in and out

By tilting the lotok in the manner to induce water to flush in and out, the lightest particles (= lights) exit as tailings while the heaviest particles (= heavies) remain stranded on the bottom of the lotok tray as a lag deposit.

Practice is imperative to ensure valuable heavies are not swept out with the tailings, and that the influx of wash-water leaves undisturbed the settled heavies.

The overarching goal is to create and maintain a shear plane between a semi-static lower layer of heavies with interstitial water, above which travels a thin film of water moving fast enough to cause the lights to become agitated, to slide and roll, to saltate, and finally to be lifted into suspension and ejected with the outflow as tailings.

Upgrading by flushing side-to-side

By moving the hands in unison gently to the left and then to the right a thin wave-led surge of water races at right angles across the lotok tray to impact and ricochet from the lotok sidewall at right angles, and thereupon shear across the lotok tray that is by now moving in the opposite direction. The surge of water is of a thin film only, a mere couple of millimetres deep. The overarching goal remains the same.

Upgrading by flushing in an ellipse

By rotating the hands in unison in a tiny ellipse, a thin surge of water races across the lotok led by an arcuate curving wave front that impacts with the lotok sidewall to be refracted back at various oblique angles, and thereupon become complicated by eddies generated by the rotary movement of the hands fortified by the return movement of the hands. The surge of water is of a thin film only, a mere couple of millimetres deep. The overarching goal is as before.

All three motions – to-and-fro, side to side to ellipse – are deceptively simple for it is common for a novice to flush out the heavies with the tailings, or be excruciatingly slow, or even create a temporary standing wave by constructive interference of wave fronts that so energises the central area of the tray that a ‘bald patch’ is eroded through the lag deposit of heavies.

Lotok as a thin-film separator

In general the flushing action used to achieve gravitational separation of lights and heavies is by means of a film of water only a few millimetres deep. It is for this reason that the lotok should, in the opinion of the author, be classed as a type of thin-film separator allied closely to shaking tables, vanners and belts. As a class, thin-film separators are sometimes capable of remarkably high percentage recovery of gold as fine as 70-100 microns or even smaller. Qualitative observations indicate that the lotok performs much less satisfactorily, in line with the western-style gold pan, but the fact the lotok is classed as a thin film separator suggests that it has potential for development as a fine gold collecting device.



Figure 15.

A professional panning lady using a lotok to upgrade concentrate at the Berleg Mine in north Mongolia. An old enamelled metal bath is being used as the water bath and she is seated on a small stool and wearing rubber kitchen gloves. A colleague stands by with a magnet ready to remove magnetite from the concentrate. (photo: Robin Grayson)



Figure 16.

Close-up view of a series of wave fronts charging side-to-side across the lotok, generated by the operator moving her hands from left to right and back again. (photo: Robin Grayson)



Figure 17.

Another technique being used by Minjin Batbayar – he has tilted the lotok sufficient that even the furthestmost tray (left) slopes towards its exit. Additional wash-water has rushed in while an underflow of tailings has sheared out. The lag deposit of heavies has streaked towards the exit but is retained in the lotok. (photo: Robin Grayson)



Figure 18.
Close-up view of streaking of black sand along the bottom of a lotok, showing it to be a thin-film separator for the final concentrating. (photo: Robin Grayson)



Figure 19.
Another view of streaking of black sand along the bottom of a lotok, but a more complicated phase, with deeper water now over the streaked black sand. (photo: Robin Grayson)

Lotok – old North American cousins?

The author attempted to determine if patents for lotoks had appeared in the United States, even though they are virtually unknown in North America.

A trawl of the US Patent and Trademark Office website (www.uspto.gov) yielded two 19th century patents of devices that show affinities to lotoks and are precursors of the Le© Trap gold pan, Gordon gold pan and Grizzly gold pan that emerged in the last few decades.

Dana oscillating shoe (patented 1892)

Arthur L. Dana of El Paso County in Colorado, California was awarded US patent #481,550 on 30th August 1892 for his *"Ore Washer and Concentrator"* [15] designed to process wet placer ore, dry placer ore or milled hard-rock ore from stamp mills, as shown in figure 18. His device consisted of a manually driven oscillating frame that oscillates a lotok-like *"shoe"*. The shoe consists of two trays inclined together in a V-shape with a collecting slot where the two trays abut. The gold concentrate is removed from beneath the slot by a nozzle with a screw thread. To empty the tailings, the lotok-like shoe is tipped (see figure 20).

A screen inserted in the lotok-like shoe consists of three joined sections; two side sections sloped parallel to the slope of the trays of the lotok-like shoe and a central section being essentially flat to create a false bottom.

Arthur Dana notes, *"By means of this apparatus the gold is separated without the use of quicksilver. The apparatus is also useful in places where water is scarce"*. His invention does not appear to have gained widespread acceptance yet it may have been a precursor of the Le© Trap gold pan, Gordon gold pan and Grizzly gold pan that emerged 90 to 100 years later.

Hussey's ribbed pan (patented 1907)

Thomas Hussey of Hollywood, California was awarded US patent #840,333 on 1st January 1907 for his *"miner's gold pan"* [16]. His device consists of a central bow-shaped tray joined to a slanted tray on either side, with a transverse riffle-like rib along the line suture with each slanted tray. In a variant, Hussey eliminates the central tray and the pair of slanted trays joins in a gentle V-shape in the manner of a lotok.

Ore is put on the central area with water and the operator causes material to be flung over the transverse riffles onto the slanted trays. Each slanted tray bears longitudinal corrugations to split the water; the heavy particles concentrating in the troughs. On the higher part of each slanted tray, the crests between the troughs are perforated to allow the light particles to be swiftly discharged with the tailings water, *"...thereby "getting rid of the lighter particles much more quickly than is possible with the ordinary pan."*

The presence of the perforations precludes Hussey's device from being operated in the manner of a lotok.

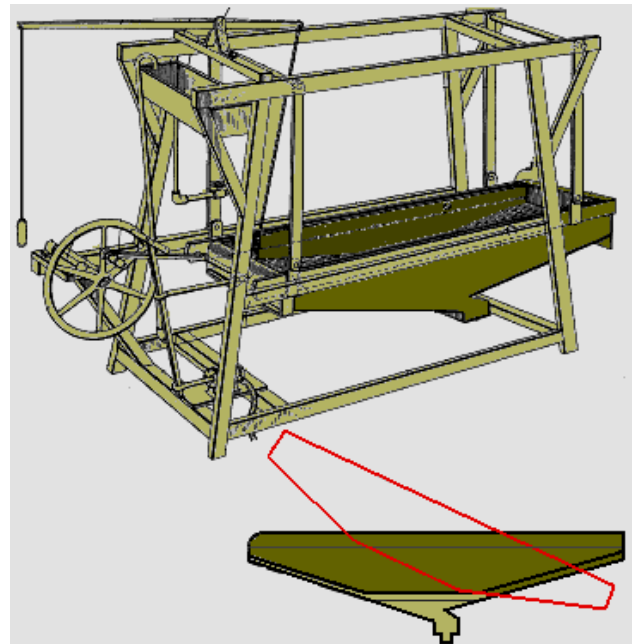


Figure 20.
Dana's oscillating shoe has lotok-like features, but differs in that the shoe is not used with one tray horizontal except when tipping out the tailings. The second difference is that gold concentrate is recovered from the shoe along a slot where the paired trays abut, whereas no slot exists in a lotok. (drawings: simplified from Dana's 1892 patent)

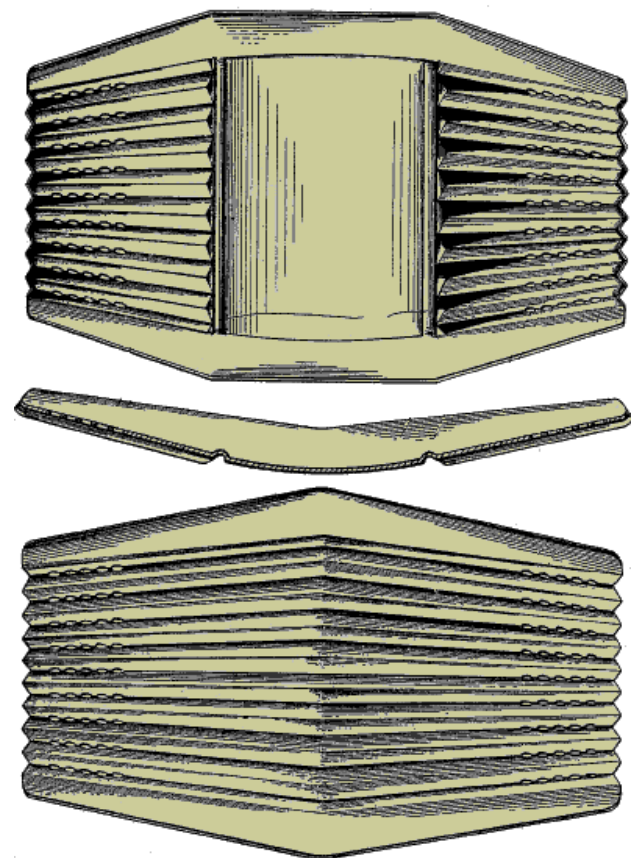


Figure 21.
Hussey's ribbed pan has a lotok-like V in one variant (lower drawing). Note the longitudinal corrugations on the slanted trays and the presence of five perforations on the crests of the corrugations as they begin to approach the end of each tray. (drawings: simplified from Hussey's 1907 patent)

Lotok – recent North American cousins?

The lotok is fundamentally different in its appearance and operation from the traditional gold pans of North America. Yet in recent decades some innovative devices in North America suggest a certain degree of convergence.

A search of the US Patent and Trademark Office (USPTO) website (www.uspto.gov) yielded three examples of patented devices that show some resemblance to a lotok: the Le© Trap gold pan, Gordon gold pan and Grizzly gold pan. Only recently have patents in the USPTO archive been put on line. The USPTO search was intensive but it is possible more lotok-like devices await unearthing.

The following comments, ideas and observations arose in a thread on the Alaska Gold Forum (AGF) with the title 'What a lotta lotoks' that started in January 2007 and are used to update the present article. While the opinions are robust, and the writers are experts at panning, the comments are provisional pending comparative trials of the operation of lotoks and these North American devices.

Le© Trap gold pan (patented 1981)

According to David Bryce (Zooka of Alaska Gold Forum AGF), the lotok method is about the same method as used with the Le© Trap. This device was invented by Mr. Jay J. Litrap of Seattle in Washington State USA, who filed a patent application in 1980 and was awarded US patent #4,289,241 in 1981 [9].

The Le© Trap is an oblong pan with inbuilt ruffles on the exit plate, and is currently made in Canada and distributed widely. Details are available at: www.dmdetectors.com.

Zooka notes that these ruffles are rather tall if attempting to recover very fine gold. As with the lotok, "with the Le© Trap, the side-to-side movement every once in a while is also very important in getting the material to stratify properly." Zooka considers the Le© Trap pan "is much faster" than a round pan on either ore or concentrates, though he notes that practice is required before trying to recover <50 micron gold. Zooka also comments that the Le© Trap pan has a wide exit lip that assists volume panning.

Zooka comments that making the lotok out of wood should "dramatically improve the fine gold trapping ability over metal" and reports that the front quarter of the Le© Trap pan "has tiny, tiny ridges machined in, set in a cross hatched circular pattern" that help arrest <100 mesh gold while the black sands are winnowed away.

Zooka notes "Though the Le© Trap and the Lotok look fairly different, the Le© Trap uses basically the same technique to classify and get rid of waste. I anticipate that a person trained in using both might find the Le© Trap to be faster, due particularly to the ruffles built in."

The Le© Trap pan may have the right combination of speed, operator comfort and ability to catch some fine gold to become a rival to the lotok, pending comparative trials and marketing effort.

Gordon gold pan (patented 1983)

In a trawl of the US Patent and Trademark Office website (www.uspto.gov) the author found US patent #4,400,269 awarded to Charles Gordon Junior of Montclair, California in 1983 [17]. In his patent, he describes 2 types of pan both with modest resemblance to a lotok. It seems the Gordon pans are no longer made.

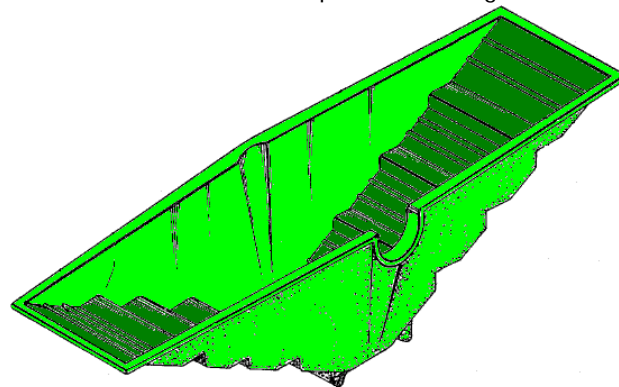


Figure 22.

The Gordon pan has some lotok-like features, but the V-shape is much tighter and the tilted trays have ruffle-like steps. The device is small enough to be held sideward and can be operated with one hand. (drawing: simplified from Gordon's 1983 patent)

Grizzly gold pan (patented 2004)

According to David Bryce (Zooka of AGF), the Grizzly gold pan seems to use a method comparable to the lotok. The Grizzly pan was invented by Clarence W. Ashcraft of Illinois who was awarded US patent #6,095,342 in August 2004 [10]. Videos on its use are on www.slucebox.com

Although the grizzly gold pan opts for a v-shape reminiscent of the lotok, it is rather different in operation and the gold is emptied via a rubber bung in the v-slot. JOE_S_INDY of AGF warns, "Just be very sure, and then very sure again to NEVER lose the hard black rubber 'plug' at the very centre. Not a common hardware part!"

Deserdogca of AGF comments, "With a grizzly gold pan, I hold with a hand on both sides and move back and forth And the heavies settle to the bottom of the vee." The lotok is too large to be held comfortably in this manner, and Deserdogca adds, "As the lotok is larger and buoyant, you would be imparting the same motion by grasping one end with both hands and moving the lotok away from you and toward you."

Deserdogca also draws attention to a novel method of preventing black sand from packing in the bottom of the Grizzly gold pan, a circumstance that does not seem to occur in a lotok, "I got some small, 3/8 inch chrome steel ball bearings, 10 of them, and put them in my grizzly gold pan before I started panning today. And they worked great! They kept the black sand loose, and I still recovered some very fine gold, along with some tiny beads of mercury. The ball bearings did not wash out when using the pan. But before I emptied my grizzly gold pan, I tried using the method seen with the lotok, using one end to wash out the waste. That worked great also. I was able to reduce about 3 gallons of material to about 2 tablespoons of material in 10 minutes."

Lotok as candidate for BAT

Best Available Techniques

No previous assessment seems to have been made to determine if the lotok is a candidate for Best Available Techniques (BAT) in spite of its wide use by companies.

Operational advantages

The lotok offers many advantages:

- ✘ low operating cost if labour is cheap;
- ✘ zero to minimal capital cost (e.g. carve out of wood);
- ✘ before lotoking, easy to remove oversize from the lotok and check for any large nuggets;
- ✘ motion creates and maintains water flow around the lotok, enabling suspended fraction (especially clays) to be removed by deliberate decanting (spillage);
- ✘ much low density sand and silt removed by gentle lotoking;
- ✘ streak of black sands left as a smear on bottom of lotok;
- ✘ easy to see coarse gold in the lotok;
- ✘ no risk of lotok being lost by sinking, being made of wood;
- ✘ easy to use buoyancy of water to support the lotok; and
- ✘ very easy to shift location quickly, and at minimal cost.

Operational disadvantages

Like other manual gold recovery devices, the lotok has its limitations:

- ✘ labour intensive and requires skill, strength and stamina;
- ✘ fine gold is impossible to see without a good hand lens (x20);
- ✘ very fine gold cannot be seen without a microscope (x100);
- ✘ black sand can sit on top of fine gold in the bottom of the lotok, completely hiding the gold from view; and
- ✘ difficult in cold weather, but this is easy to solve as a lotok fits snugly into a small narrow bath of slightly heated water.

Environmental factors

Environmental factors for the lotok are similar to other manual methods of gold recovery:

- ✘ risk to topsoil resource – not a direct factor;
- ✘ risk to mineral resource – oversize removed manually, ensuring large nuggets are detected; but still a risk of poor gold recovery if lotoking is not done properly, if too much sticky clay is present or if the gold is very fine or flat;
- ✘ risk of dust generation – not a factor;
- ✘ risk of sheet runoff and effluent discharges – not a factor;
- ✘ acidic waters rich in heavy metals – tiny risk with placer but greater with hard-rock as:
 - ★ acidic waters may result by oxidation and hydration of sulphide minerals notably pyrite (FeS_2); and
 - ★ heavy metals may endure acidic leaching and be liberated.
- ✘ risk to surface waters – risk of acidic waters and heavy metals from lotoking sites.
- ✘ risk to biodiversity in general – disturbance to wildlife by noise, muddy water and waste; and
- ✘ risk to freshwater ecosystem – fish feeding, migration and spawning, and the freshwater ecosystem overall, may be adversely affected by an increase in turbidity and sediment, especially if many lotoks in a small slow stream; and
- ✘ risk of poor land reclamation – ground may be left damaged, particularly from the hummocks, shafts and tunnels abandoned by miners, and to a far lesser degree by the tailings from lotoks.



Figure 23. *Minjin Batbayar holding a lotok clear of the water in the bath in order to inspect the contents. The process is slowed and then halted by the lifting action. (photo: Robin Grayson)*



Figure 24. *By moving the device from side to side, Nick Grayson has produced a pair of wave fronts that are racing from side to side across the lotok. (photo: Robin Grayson)*



Figure 25. *Nick Grayson has produced a pair of static waves caused by the underflow towards the v-depression when he tilted the lotok to a symmetrical horizontal position. (photo: Robin Grayson)*

Key factors in BAT determination

The key factors in assessing the lotok appear to be:

- ✘ probably good % gold recovery (but no tests reported);
- ✘ risk of effluent of muddy silty water;
- ✘ tailings with heavy metals (but stable if from normal placer);
- ✘ if hard-rock ore, a significant risk of acidic waters and leaching of heavy metals; and
- ✘ risk of water-related illnesses are a concern; and
- ✘ physical injury from strains is also a concern, but not so if:
 - ★ operator wears waterproof gloves, boots and apron;
 - ★ the water is kept at a comfortable temperature; and
 - ★ lotok used in a raised water bath to enable a standing posture.

Comments on BAT and lotoks

Although the lotok has existed since at least 1935 [4] and probably since the late 1800s, the author is unaware of any scientific tests having been published on the performance of the device. This requires meticulous field tests and stringent laboratory testing using tracers.

To assist ASM, assessment should focus on the percentage of fine gold and flat gold that the lotok is capable of recovering, particularly in comparison with other wooden devices such as the batea, and conical dalang to determine the optimum wooden device for ASM.

To assist companies, the precise capability and limitations of the lotok merit urgent study, as this was often the only device used in determining the grade of intervals examined by prospect pits and Soviet churn drills (= cable drills). A correction factor for the loss of fine and flat gold needs to be estimated by tracer tests, allowing a revision to grade, resource and reserve of virgin placer and tailings. The lotok remains the “device of choice” of most drillers and geologists in the former Soviet Union and Mongolia today.

BAT assessment of lotoks

Pending detailed field observations and technical study, the provisional assessment of lotoks made of wood is that they are potential candidates for BAT (Best Available Techniques) for manual recovery of gold [13], subject to a set of stringent conditions:

- ✘ if the stream is at its low-stage, do not use unless the stream is very wide even at the low-stage (but brief prospecting lotoking is acceptable);
- ✘ never use in ephemeral or tiny streams (but brief prospecting lotoking is acceptable);
- ✘ limit the number of users in a single stretch of a stream;
- ✘ never use mercury (Hg) in the lotok or before or after;
- ✘ do not process ore that contains significant mercury (Hg);
- ✘ do not process ore that contains significant cinnabar (HgS);
- ✘ check for fine gold by hand lens (x20);
- ✘ check for very fine gold by binocular microscope (x40, preferably x100); and
- ✘ if the ore has pyrite (FeS_2) or other easily decomposed sulphide minerals, then:
 - ★ lotoking away from water-courses or springs;
 - ★ avoid making large accumulations of waste;
 - ★ avoid mounding of waste, to minimise acidification;
 - ★ seal waste using clay, to reduce water ingress and minimise acidification; and
 - ★ ask specialist to determine where and how to dump waste to minimise acidification.



Figure 26.

B. Altanzul tilting a lotok away from her to encourage fines to slide out as tailings at the same time as enabling an inflow of new wash-water. Notice the gold being dense remains static in the crease of the v-shape provided the lotok is not tilted excessively. The lotok is narrow in order to fit snugly inside a metal water bath suitable for prospecting purposes. (photo: Dr. Baatar Tumenbayar)



Figure 27.

A metal lotok manufactured by cutting thin metal and welding the pieces together with precision. Kyrgyzstan. (photo: AVISTA of Bishkek)



Figure 28.

The same metal lotok in use in a stream in Kyrgyzstan by a geologist. Notice the difficulty of using the lotok in moving water and the difficulty of the geologist in maintain this cramped posture for more than a few minutes. (photo: AVISTA of Bishkek)

Discussion

Although the lotok belongs to the broad group of gravitational recovery devices that are directly powered by hand, the lotok is little known outside the former Soviet bloc. Why the lotok dominates the large soviet placer industry yet failed to spread worldwide merits discussion.

It seems the lotok excels in a key step in upgrading concentrate – provided a water bath is installed. Without the water bath the operator is forced into a hunched posture quite untenable for long periods, and this may be the prime reason why the lotok was rejected by the artisanal miners of Mongolia. This may also account for the lotok failing to make any dent in the popularity of the pan amongst western geologists and recreational miners.

How a lotok actually functions remains largely unclear in the absence of published test results and the paucity of detailed observations in the literature. However the author's observations show that the lotok is primarily activated by a to-and-fro and side-to-side motion with only limited intervals of small oscillations, whereas the North American gold pan is often swirled rather drastically [18].

It seems the lotok is best classed as a type of thin film separator and if this classification is correct it raises the possibility that the lotok might be developed into a fine gold collector, albeit with much effort.

Although the lotok is primarily a thin film separator, the operator often resorts to tilting the device quite steeply away from him/her and the contents begin to be tipped out. In this manner the thin film separation is interrupted and for a moment the lotok operates as a different class of device with material sliding down slope while water above rushes in. This is reminiscent of the retreat of water down a sloping shore after a wave has crashed.

Another scenario is when the operator brings the v-crease to a symmetrical position compelling the water in the lotok to charge towards the v-crease. The underflow is fierce as indicated by a static shear wave on the water surface. This drastic action drives the heavies including the gold towards the v-crease, and the author is not able to relate this action to any other gravitational separation device. Upon the return of the furthestmost tray to a horizontal position the water surges away from the v-crease and exits the lotok taking the lights with it. At the same time the black sand may also race along the floor of the tray towards the exit, leaving a static lag deposit of gold in the v-crease. This action seems similar to what occurs when a pan is tipped up, with gold left as a static lag in the crease around the base of the pan wall. However as the lotok tray is far longer than the height of the pan wall, the lotok is probably technically superior in this one respect.

It is evident that the lotok holds many secrets and it is hoped that this brief introduction will inspire others to begin detailed tests and observations of a device that is central to daily production of clean smeltable concentrate by the world's largest producer of placer gold – the Russian Federation.

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Figure 29.

Minjin Batbayar of Eco-Minex supervising a lotok operator. The lotok is in an improvised water bath. Dr. Tumenbayar used copper filings as tracer and determined about 85% gold recovery by this operator. (photo: Dr. Baatar Tumenbayar)

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