

# Gold recovery in buckets in Kyrgyzstan - the term 'bucketing'

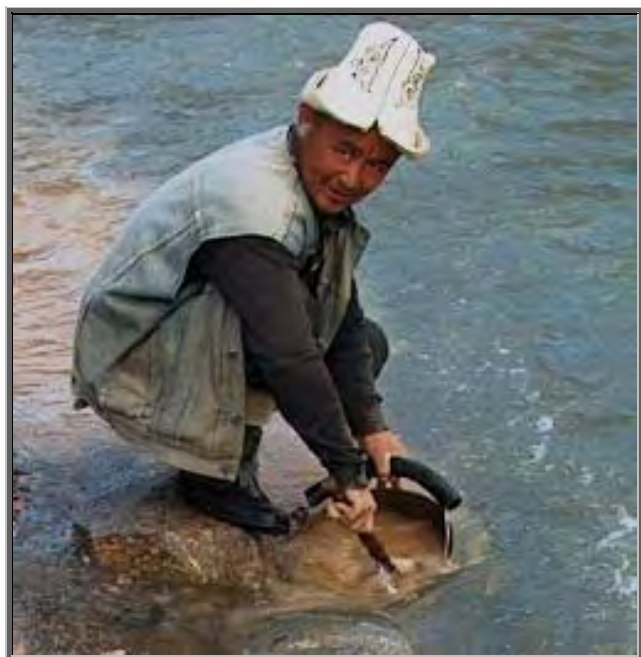
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## About the Author



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 is a Short Note to draw attention to buckets having a useful role in gold recovery. The term 'bucketing' is proposed to ensure the distinctive nature of operating a bucket is not smothered by the term 'panning'.

The term 'panning' remains useful in colloquial English to cover all manner of hand-driven gravitational gold recovery devices. Yet within the multitude of devices the bucket is distinctive.

The bucket is a household galvanised metal bucket modified by sliding over a rubber sleeve over the metal handle.

The bucket is used by artisanal and small-scale miners (ASM) in Kyrgyzstan, notably in the mountainous valleys of Naryn Oblast, for recovering placer gold by manual wet washing.

The bucket is part filled with clean water and then topped up with pay gravel tipped from a sack. The handle of the slurry-filled bucket is grasped firmly in one hand and lowered into a swift stream. Clean water flushes in and dirty water flushes out. The operator turns the handle to make the submerged bucket oscillate to-and-fro, swirling out more fines.

The operator pauses to prod the contents with a short stout stick to loosen the contents, and reaches into the bucket to grab large stones and eject them – after checking for nuggets.

**Figure 1.**

*A Kyrgyz miner using a bucket to wash pay gravel in a mountain stream in the Tien Shan mountain range. His method is simple and at least as effective as most other methods of recovering placer gold. (photo: Robin Grayson)*

## What is a bucket?

The term 'bucket' in mining refers even to dredge buckets and excavator buckets, so it is useful to begin by clarifying the meaning. In this article, a 'bucket' is defined as: **a cylindrical vessel used for holding or carrying liquids or solids**. The term is synonymous with 'pail', and it is implicit that a handle ('bail') is attached to enable the bucket to be readily carried by one hand, and to assist in lifting, lowering, tilting and pouring.

The handle is of flexible material such as rope or wire, or made of more rigid material such as metal or plastic. The bucket is free to swing freely on its handle. Of importance, a rope handle can twist and recoil whereas a rigid metal handle swings to-and-fro in a single plane.

Metal buckets have been made since at least the 1,000 B.C. Metal buckets of iron, copper and bronze were items of high-prestige or else used for cooking, the handle being used to suspend the bucket in cauldron fashion over a fire.

Wooden buckets are known from the Iron Age, but have been largely replaced by mass-produced metal buckets, in turn supplanted by utilitarian plastic buckets. Apart from low cost, lightness and ease of stacking, plastic allows buckets to be made in an extraordinary range of shapes, and with great diversity of handles, lids, pouring lips, spouts and handles.

## Bucketing – a proposed new term

The author proposes the term 'bucketing' in order to permit a narrow technical description of the process of using a simple bucket with rigid handle as a device to achieve the initial gravitational recovery of heavy minerals (gold, platinum, tin, diamonds, gems etc.). By adopting this term 'bucketing' it helps reduce confusion with the broad term 'panning' as exemplified with the operation of the North American gold pan [1].

'Bucketing' is defined as: **removal of tailings by agitating pay gravel in a bucket by variously twisting and turning the handle by hand, and variously tilting and turning the bucket by hand**.

In the narrow sense, bucketing does not involve any screening to remove oversize for the oversize, once thoroughly washed is ejected by hand. Meanwhile the light undersize is removed by winnowing into the water.

In a wider sense, bucketing can involve screening of oversize and even the use of several screens to create different size fractions of washed material.

The term 'panning' [2,3] retains merit as an everyday expression for all manner of gravitational washing devices that are directly driven solely by hand movements; but overuse of the term 'panning' debilitates proper technical assessment of devices as diverse as the pan [1], batea, dulang [4], lotok [5], bucket, ribbed mat [6] and washing-up bowl [7].

This account is limited to a simple form of bucketing with a simple circular metal bucket plus metal handle. Other forms of bucketing are mentioned in the Discussion.

## Bucketing in gold recovery

Artisanal and small-scale mining is widespread in the upland valleys of Kyrgyzstan [8]. The author accompanied members of the PROMA consultancy, AVISTA consultancy and the State Geological Agency of Kyrgyzstan on several visits to advise artisanal miners in Naryn Oblast. The following account describes bucketing by a small group of miners in summer 2000, who supplement village incomes by informal (illegal) gold mining.

## Mining the ore

The placer had been mined by soviet companies. During the visit, the artisanal miners were painstakingly cleaning the base of the placer resting on an irregular bedrock surface. Implements were hand-tools, notably picks, shovels and crowbars. Recovery of pay gravel was by 'oskar' metal reinforcing bars, brushes made from bundled twigs, and plastic scoops (see figures 2 and 3).



**Figure 2.**  
*An artisanal miner using a modified metal bar ('oskar') to dislodge pay gravel from crevices of bedrock at the base of a mined-out placer. (photo: Robin Grayson)*



**Figure 3.**  
*The same miner using a home-made brush to sweep the pay gravel into a plastic scoop for transferring into a cloth flour bag. (photo: Robin Grayson)*

## Transporting the ore

The placer ore is transported in a flour sack. The sack is only part-filled, not only to lighten the load but also to enable the mouth of the sack to be grasped by both hands. This allowed the sack to be slung over the shoulder (see figure 4). In this example the sack is being carried barely 200 paces. In other instances jeeps are used to transport sacks for longer distances to the stream.



**Figure 4.**  
Carrying a bag of ore to the washing site. (photo: Robin Grayson)

## Loading the bucket

The bucket is part-filled with clean water from the stream and rested on the ground alongside the bags of pay gravel. A bag of gravel is then grasped by two hands and, supported on the hip, the contents are poured into the bucket (see figure 5).

The poured material falls 20-40 cm into the water and a great deal of agitation and frothing occurs during the filling (see figures 5 and 6).

The bucket is filled to the brim, and material is lost over the top of the bucket and by leakage out through the handle holes (see figure 6).



**Figure 5.**  
Artisanal miner pouring pay gravel from a sack into a bucket part-filled with water. The view showing all equipment – sack, bucket, gold pan, in-stream sluice and in the background a short stick for prodding the bucket contents. (photo: Robin Grayson)



**Figure 6.**  
Although the pouring of dry pay gravel into the water ensures much turbulent wetting of the particles, it also risks ejecting valuable slurry over the sides, and in this instance through a rivet hole of the handle attachment. (photo: Robin Grayson)

## Transporting the bucket

The full bucket is lifted by hand by the handle, and carried a few paces to the riverbank. The full bucket is heavy and carrying it demands considerable strength. This would be impossible for young children and most women.

The importance of the black rubber sleeve around the handle is now evident. Without this item having been added, the full bucket could not be carried without damage to the hand, regardless of how strong an individual happens to be (see figure 7).



**Figure 7.**  
Carrying a full bucket to the stream. Notice the strain to the hand. (photo: Robin Grayson)

## Washing sequence

Washing consists of three sequential steps:

- ✘ **bucketing:** reducing fines and removing oversize;
- ✘ **sluicing:** reducing fines even more; and
- ✘ **panning:** to produce the final gold concentrate.

The washing operations are very compact, the bucketing being conducted only a couple of metres from the in-stream sluice (see figure 8), and the final panning is conducted in the midst of these activities.

## Bucketing – preliminary actions

The miner carries the full bucket to the water's edge and stands firmly on a large flattish boulder at the water level. The miner stoops to lower the bucket into the fast-flowing stream, with the bucket rim kept just above the water-line. As a safety measure the bottom of the bucket is a few centimetres above a submerged flat boulder.

The miner crouches low, folds down the handle, and tilts the bucket upstream using two fingers. Sediment-laden water pours from the bucket, at the same time clean water surges in. The resulting turbulence in the bucket puts more sediment into a suspension that is rapidly ejected as tailings by the strength of the flow.

Grasping a short stout stick, the miner prods and stirs the contents of the bucket to agitate the sediment and encourage yet more sediment into a suspension ejected from the bucket (see figure 9).

Although much of the fines are winnowed away by the tilting of the bucket and prodding and stirring the contents with a stout stick, these measures are insufficient to complete the process. Indeed, to tilt the bucket more than a few degrees would risk all the valuable heavies being scoured out by the powerful surge of stream water and associated eddies.

## Bucketing – main actions

The miner bends his knees in a tense 'jockey' posture to lower the bucket into deeper water (see figure 11).

The miner holds the handle in such a manner that the bucket is now submerged except for the top centimetre or so. This grip requires considerable strength for although the heavy bucket is now largely supported by the water, the pressure of the fast-flowing stream is considerable and the body posture is taunt.

The miner alternately sinks and raises the bucket gently to cause a plume of sediment-laden water to be ejected and clean water to surge in.

The miner then starts twisting the handle alternately clockwise and anticlockwise to impart a tick-tock to-and-fro oscillation to the bucket. This generates a swirling effect in the contents and greatly accelerates the flushing process (see figures 10-12, 14 and 15).

Occasionally the miner rests the bucket slightly submerged on a flat boulder on the stream bed, while stirring the contents vigorously with a stout stick grasped by both hands (see figures 13 and 16).



**Figure 8.**

*In the background an artisanal miner wearing the traditional Kyrgyz felt hat has commenced bucketing in the stream. In the foreground a second miner is emptying the contents of his bucket into an in-stream sluice. (photo: Robin Grayson)*



**Figure 9.**

*Close up of the artisanal miner grasping a stick to agitate the contents of the tilted bucket in the fast-flowing stream. (photo: Robin Grayson)*



**Figure 10.**

*Notice the grip of the hand to allow a tick-tock motion of the bucket. (photo: Robin Grayson)*

## Bucketing



**Figure 11.**  
*Bucketing underway, the miner lifting the bucket slightly to shed a plume of tailings in the midst of the tick-tock motion. (photo: Robin Grayson)*



**Figure 12.**  
*A moment later, the handle is now north-south and much frothing and splashing is apparent due to the rotation of the bucket. He is turning the bucket with his left hand, while his right hand holds a short stout stick ready for the next stage (photo: Robin Grayson)*



**Figure 13.**  
*After a few minutes, the miner has ceased the tick-tock motion and lowered the bucket to rest on a submerged flattish boulder. He is now energetically mixing the contents of the pan using a stout short stick grasped in both hands. (photo: Robin Grayson)*



**Figure 14.**  
*Close-up of the picture shown opposite. (photo: Robin Grayson)*



**Figure 15.**  
*Close-up of the picture shown opposite. (photo: Robin Grayson)*



**Figure 16.**  
*Close-up of the picture shown opposite. (photo: Robin Grayson)*

## Sluicing

Having completed the bucketing operation, with most of the light sand, silt and clay winnowed out, and some of the larger washed pieces removed by hand, the bucket is carried to the stream bank.

The contents of the bucket are tipped slowly into an in-stream sluice (see figures 17 and 18). The bucket is refilled with clean water to allow the final contents to be flushed out into the sluice.

The sluice-box is a metal tray about 50 centimetres wide and about 1.5 metres long. The two longitudinal sides of the sluice are bent into perpendicular flanges each about a centimetre all.

The sluice-box is positioned in the edge of the stream bed to intercept some of the stream flow, the objective being to fill the sluice evenly with a steady flow of clean water. Cobbles are positioned to weigh down the sluice. The flow is constrained within the vertical flanges of the longitudinal sides of the sluice-box.

The bucket's contents are poured into the upstream end of the in-stream sluice. The heavy concentrate is trapped without using any metal riffles, solely by a black ribbed rubber mat that is slotted into the downstream end of the sluice. The rubber mat has been carefully cut to slot quite tightly into the sluice-box, and it seems likely that the raised flanges of the sluice are slightly bent inwards to grip the mat. Inserting the mat is by sliding it in from the downstream end of the sluice-box (see figure 21).

The water in the sluice is little more than a centimetre deep and the cross-hatched ribs of the mat create matching standing ripples in the water surface.

The miner watches the flow over the rubber mat to remove oversize by hand. The oversize is mostly less than 60-80 millimetres in diameter as larger oversize had been removed earlier from the bucket by hand.

The sluicing operation requires only a few minutes as pre-washing and winnowing had already been done by the bucketing and the flow of water is strong and steady.

## Panning

Once the sluicing operation is complete, the miner carefully slides the rubber mat out of the outflow end of the sluice with no attempt made to interrupt the flow (see figure 19). It is to be assumed that this procedure will lose some black sand and gold expected to be trapped by the upstream step of the leading edge of the mat.

The mat is carried to a gold pan placed firmly on the ground, and the mat is curved and slanted into the rim of the pan (see figure 20). This causes the mat to disgorge its contents into the pan. The pan is home-made, being an aluminium pan with the handle removed.

The gold panning is conducted in the North American manner [1], the pan tilted north away from the operator, and the hands inducing the pan to move in a gentle orbital path causing the contents to swirl and tailings to slosh out leaving upgraded concentrate in the pan (see figure 22).



**Figure 17.**  
*Slowly tipping the washed and winnowed contents of the bucket into an in-stream sluice down which a liberated plume of fines is racing. (photo: Robin Grayson)*



**Figure 18.**  
*As above, pouring the valuable residue from the bucket into the in-stream sluice. (photo: Robin Grayson)*

## Final stages of gold recovery



**Figure 19.**  
*Sliding out the ribbed rubber mat with its cargo of concentrate from the outflow end of the sluice-box. (photo: Robin Grayson)*



**Figure 20.**  
*Loading concentrate from the ribbed rubber mat into a gold pan made from an aluminium fry-pan. (photo: Robin Grayson)*



**Figure 21.**  
*Re-inserting the ribbed rubber mat into the in-stream sluice. Note the prominent standing waves. (photo: Robin Grayson)*



**Figure 22.**  
*Panning in the same manner as for the North American Gold Pan. Kyrgyzstan. (photo: Robin Grayson)*



**Figure 23.**  
*Swirling the pan to spread out the black sand to allow gold particles to become visible. (photo: Robin Grayson)*

## Bucketing as candidate for BAT

### Best Available Techniques

No previous assessment seems to have been made to determine if bucketing is a candidate for Best Available Techniques (BAT) for artisanal or recreational miners [9].

### Operational advantages

Bucketing offers advantages to artisanal miners and recreational miners, particularly in remote areas:

- ✘ zero to minimal capital cost (e.g. old or new metal buckets);
- ✘ low operating cost if labour is cheap;
- ✘ during bucketing, easy to remove washed oversize from the bucket by hand and check for any large nuggets;
- ✘ disaggregates pay-gravel fairly easily, unless very clayey;
- ✘ to-and-fro 'tick-tock' twisting motion creates and maintains turbulence, putting more material into suspension and shedding it by deliberate decanting (spillage);
- ✘ much of the ordinary low density sand and silt removed during gentle up and down motion of the bucket;
- ✘ buoyancy of water helps support the bucket; and
- ✘ very easy to shift location quickly, and at minimal cost.

### Operational disadvantages

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

- ✘ labour intensive;
- ✘ requires skill, considerable strength, fitness and stamina;
- ✘ risk of damage to skin from prolonged gripping of handle;
- ✘ risk of bucket being lost by sinking, being made of metal;
- ✘ difficult to use in cold weather;
- ✘ best results may require a fast-flowing stream;
- ✘ bucket must be leak-free or much gold is lost; and
- ✘ cannot see gold in the bucket – it is a preliminary stage.

### Environmental factors

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

- ✘ risk to topsoil resource – not a direct factor;
- ✘ risk to mineral resource: oversize is removed manually, ensuring large nuggets are detected; but still a risk of poor gold recovery if bucketing 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 ( $\text{FeS}_2$ ); and
  - ★ heavy metals may endure acidic leaching and be liberated.
- ✘ risk to surface waters – risk of acidic waters and heavy metals from bucketing 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 affected by an increase in turbidity and bottom sediments, especially if many buckets in a small slow stream; and
- ✘ risk of poor land reclamation – ground may be left damaged, particularly from hummocks, shafts and tunnels abandoned by miners, and to minor degree by bucket tailings.

### Key factors in BAT determination

The key factors in assessing bucketing appear to be:

- ✘ probably good % gold recovery (but no tests reported);
- ✘ effluent plume 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;
- ✘ risk of water-related illnesses are a concern; and
- ✘ physical injury from strains is a major concern.

### Comments on BAT and bucketing

Proper assessment of bucketing awaits observations of artisanal miners in a range of sites differing in geology, environment and culture. The most important field observation required is to determine the cumulative impact of many people bucketing in a sensitive area. Also to observe if bucketing has any influence on the use of mercury or other chemicals in the subsequent sluicing and panning.

In addition, a technical assessment is required of the percentage gold recovery achievable in stringent laboratory testing using tracers. Technical assessment should focus on the percentage losses of fine gold and flat gold that bucketing might incur, and comparison with the performance of sluices with integral screen and hopper.

Efforts should be made to determine if bucketing can be developed further, as suggested in the section overleaf dealing with patents and innovations.

### BAT assessment of bucketing

Pending detailed field observations and technical study, the provisional assessment of bucketing is that it is a potential candidate for BAT (Best Available Techniques) for manual recovery of gold [9], 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;
- ✘ never use in ephemeral or tiny streams (but brief prospecting by bucketing is acceptable);
- ✘ limit the number of users in a single stretch of a stream;
- ✘ never use mercury (Hg) in the bucket or before or after;
- ✘ do not process ore that contains significant mercury (Hg);
- ✘ do not process ore that contains significant cinnabar ( $\text{HgS}$ );
- ✘ check for fine gold by hand lens (x20) in the next stage;
- ✘ check for very fine gold by binocular microscope (x40, preferably x100) in the next stage; and
- ✘ if the ore has pyrite ( $\text{FeS}_2$ ) or other easily decomposed sulphide minerals, then:
  - ★ bucketing away from water-courses or springs;
  - ★ avoid creating 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.

## Patents with bucket washing

The foregoing account describes bucketing by a very simple method. This uses a plain metal bucket with a simple metal handle, the only modifications being the addition of a slit rubber sleeve to cover the handle and the use of a stout short stick to stir the contents of the bucket. A plastic bucket of similar shape should also be possible, but the handle and its attachment would be prone to break irreparably with the strain, or the handle to pop free from its sockets.

A rope handle seems impractical for normal bucketing, as the rope would twist violently and trap the hand of the operator and endure rapid wear and tear. However an industrial-scale bucketing device is envisaged, with the bucket handle replaced by a cable suspending the bucket from a pivot point above.

With the help of members of the Alaska Gold Forum the author made an internet search of the United States Patent and Trademark Office (USPTO - [www.uspto.gov](http://www.uspto.gov)) for US patents of processes akin to bucketing. This was made easier by word search of US patents via Google's patent search engine [www.google.com/ptshp](http://www.google.com/ptshp).

Many old US patents were found for buckets equipped with all manner of sieves and screens, ranging from flour sieves and ash screens to removal of cigarette stubs from sand trays in hotel foyers. None of these devices shed much light on bucketing, nor suggest new forms of bucketing relevant to gold recovery.

However a single patent of considerable interest was found; the "Mega Bucks" rocker bucket gold recovery system'. This US patent (#5,423,430) was awarded to Jerry Zaffiro and William H. Farren of California in June 1995 and lapsed in 1999 due to non-payment [10].

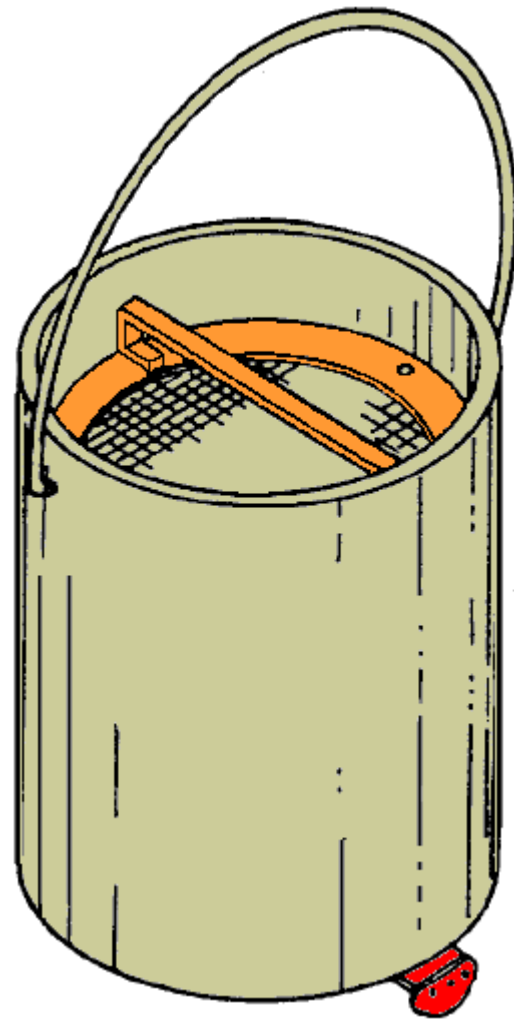
An innovation of the Mega Bucks rocker bucket is the addition of a strip-like keel across the base of the bucket from side to side. This keel is a horizontal pivot upon which the bucket is rocked to-and-fro by hand to agitate the contents. A second innovation is stacked screen compartments inside the Mega Bucks bucket to sort the material into size fractions, so speeding later panning.

An advantage of the Mega Bucks is that the rocking motion is done while the bucket rests on the ground, whereas the Kyrgyz bucket demands support by hand, albeit with some buoyancy from the stream.

A difference in the motion of the Mega Bucks is that the rocking action causes little motion in the lowermost contents but upwards the contents are rocked more strongly with the uppermost layers being rocked quite violently. In contrast the contents of the Kyrgyz bucket are shaken and stirred more uniformly.

With the innovative keel of the Mega Bucks as inspiration, a wooden keel could be added to the bottom of a standard metal bucket to add to the Kyrgyz tick-tock motion the option of the Mega Bucks rocking motion.

A different innovation would be to add a central swivel node to the base of the Kyrgyz bucket in order to support the weight of the bucket during the tick-tock motion, reduce strain for the operator, and allow a smoother faster motion.



**Figure 24.** *Oblique view of the Mega Bucks rocker bucket showing the first of the set of internal screens (orange) and the basal keel (red) upon which the bucket is rocked. (redrawn from Zaffiro and Farren patent #5,423,430)*

## Discussion

The bucket belongs to the group of gravitational recovery devices that are directly powered by hand [2,3] whose operation is colloquially known as panning. Within this group, there are no close relatives to the bucket, but the Mega Bucks rocker bucket is a link to classic rockers of the North American gold rushes of the 19<sup>th</sup> century.

It might be thought that the Kyrgyz bucket operates in a manner fundamentally different to panning with a North American pan [1]. However both types of device rely upon swirling to ensure the sediment disaggregates thoroughly, and both eject surplus water and tailings over the rim. That said, the motion of the Kyrgyz bucket is tick-tock oscillations, plus some up-and-down motion, whereas the distinctive motion of a North American pan is in a small orbit while held tilted away from the operator.

Technical study is warranted – bucketing is capable of replacing screens and hoppers for sluices and the Mega Bucks shows bucketing has some potential for further innovation as a gold recovery device.

## Acknowledgements

The author is pleased to acknowledge the valuable contributions and assistance given by the following people and organisations in preparation of this paper.

Thanks are due to: Mr. Gennady Potapenko, Leading Geologist of the State Geological Agency of Kyrgyzstan; Mr. Valery Rogalsky, Manager of AVISTA Ltd for advice about informal miners and placers in Kyrgyzstan; Mr. Akylbek Rakaev, Director of Small Diggers Artel, regarding placer mining in Kyrgyzstan; Mr. Nurlan Djoldoshev and the PROMA team in Bishkek for fact-finding and general support. Dr. Peter Appel (Greenland and Denmark Geological Survey GEUS) for his observations of Kyrgyz artisanal miners. Thanks also to the EU Tacis SME Development Programme - Kyrgyzstan (SCR-E/110958/CSV/KG) implemented by the 'Gaulhofer Consortium' consisting of Gaulhofer and Partners (Austria), AHT (Germany) and Enterprise plc (United Kingdom) and its Team Leader, Dr. David Grant. Dr. Baatar Tumenbayar, Mrs. Chimed-Erdene Baatar MBA (Eco-Minex International Ltd) and Michael Priester (Projekt-consult gmbH) gave advice and the article benefited from expertise of members of the Alaska Gold Forum. Jim Hollaran kindly reviewed the manuscript.

**This study was made possible by support from Eco-Minex International Ltd.**

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