Forecasting Lode Gold Potential From Physical and Chemical Characteristics of Placer Gold Grains: An Example from French Guiana

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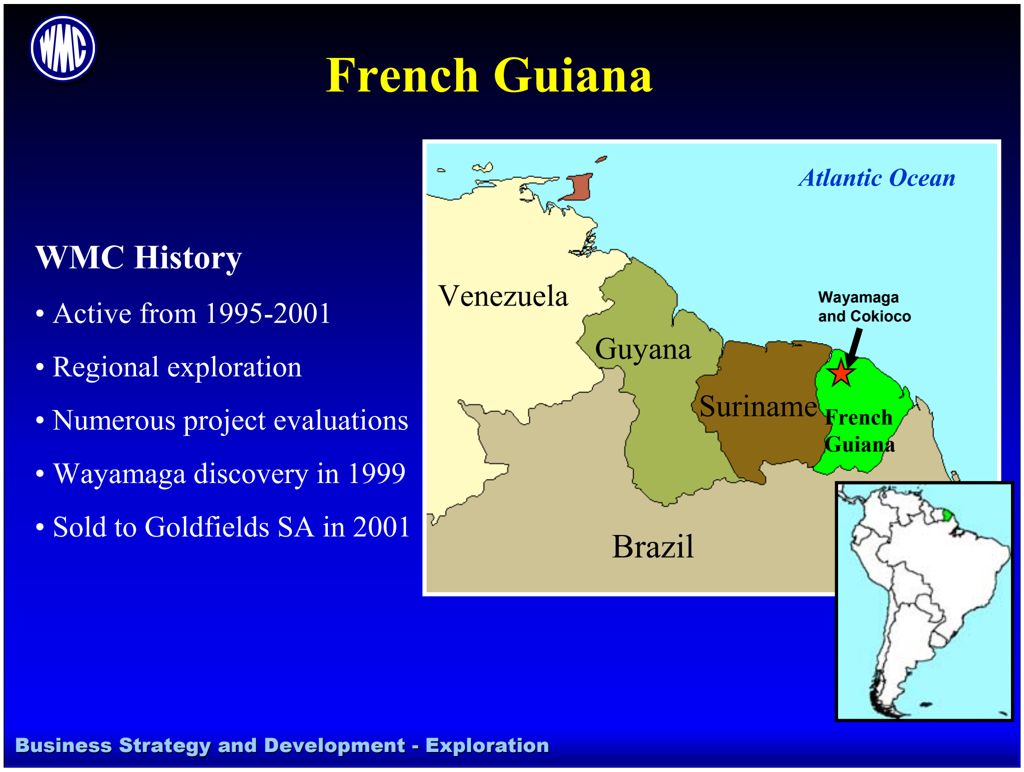
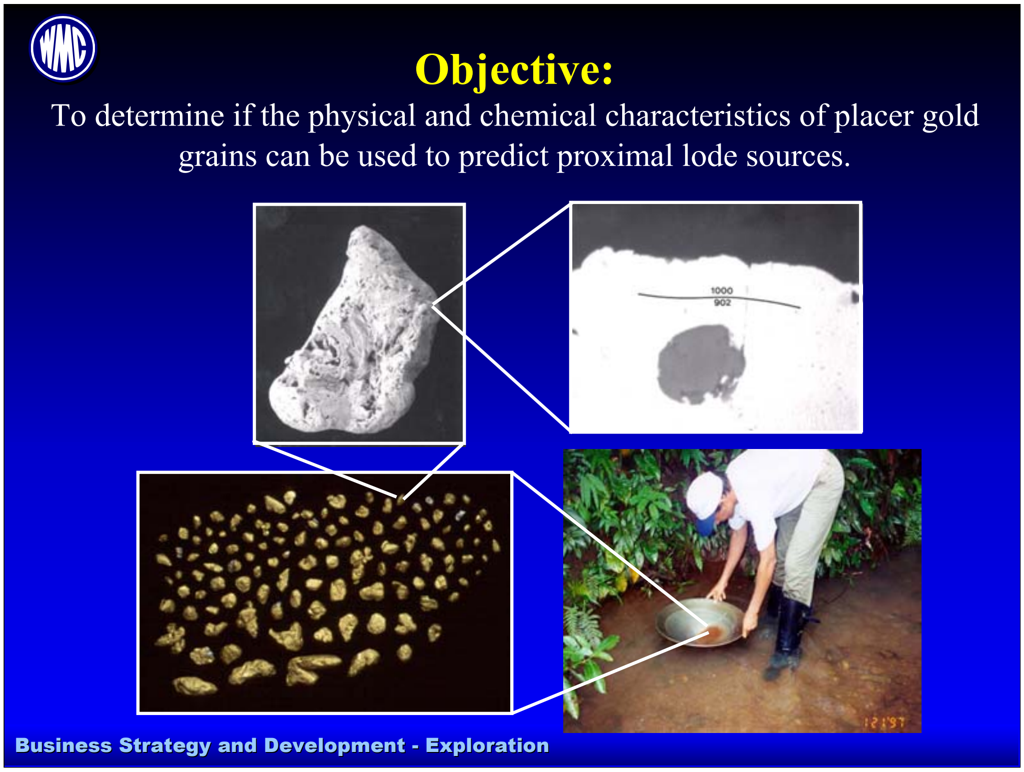
The title of this talk could have read “How to save a million dollars in your exploration budget.” Had WMC known the results of this study prior to exploration work on one of our projects, we would have done exactly that. Because of the favorable geologic environment and the extensive amount of vertical weathering that has taken place in French Guiana, residual accumulations of gold are common place. This of course, makes it difficult to quickly locate areas with lode gold potential using conventional stream sediment geochemistry or gold grain counts in panned concentrates. This study was designed to determine if the physical and chemical characteristics of placer gold grains could be used to identify areas with lode gold potential.

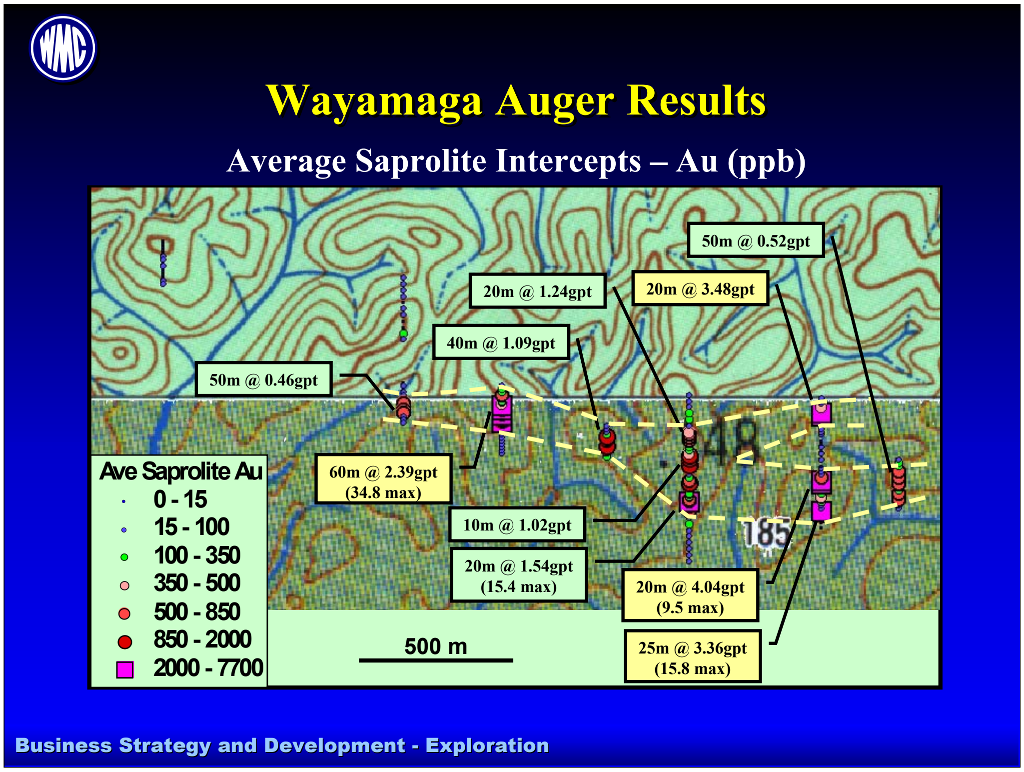


WMC explored for mesothermal gold deposits in French Guiana from 1995 until 2001, spending just over $5 million during that time. The program consisted of regional exploration and numerous detailed project evaluations. In 1999, we made what was estimated to be about a 2 moz discovery on the Wayamaga prospect, but based on this estimate, we decided not to pursue further exploration of the property, and sold it and our local operating company to Goldfields.

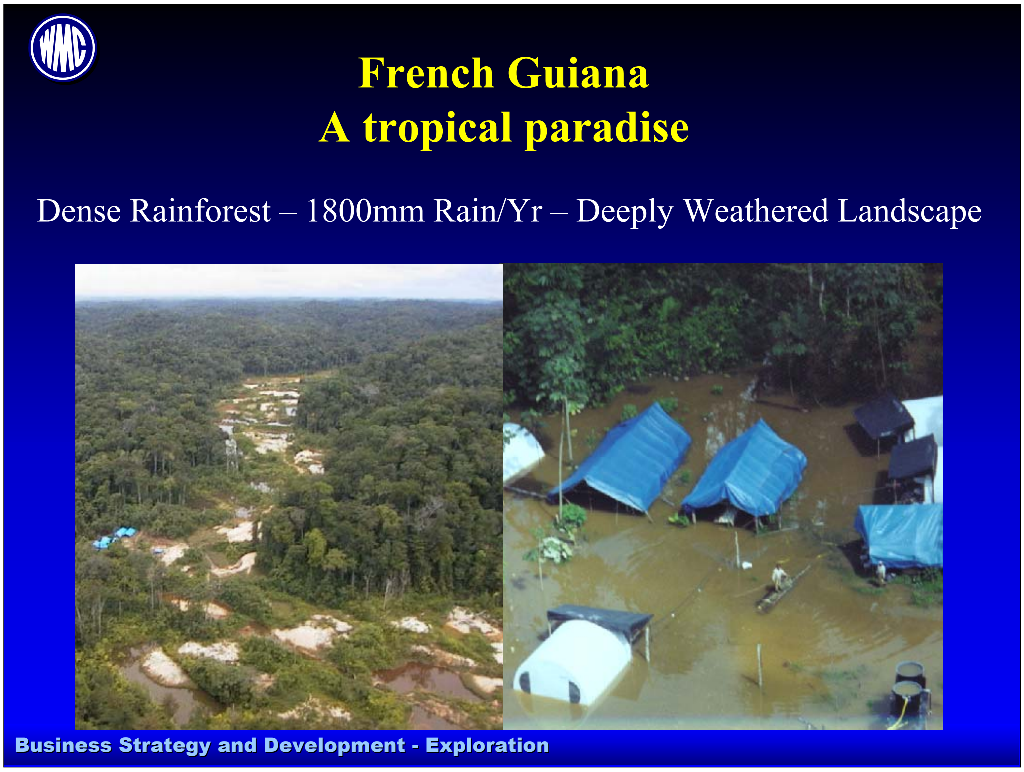
The map on the right shows the location of French Guiana, adjacent to Brazil and Suriname on the north-central coast of South America adjoining the Atlantic ocean. The location of Wayamaga and Cokioco, the two WMC project areas examined in this study, are located in the northwest part of French Guiana.



After making the Wayamaga discovery in 1999, we had the opportunity to compare placer Au grains from Wayamaga to placer gold from Cokioco where extensive exploration work failed to locate a lode source. A total of 14 panned concentrate samples were sumbitted from the properties to Overburden Drilling for physical and chemical characterization of the gold grains, and to determine if any unique indicator minerals could be found.

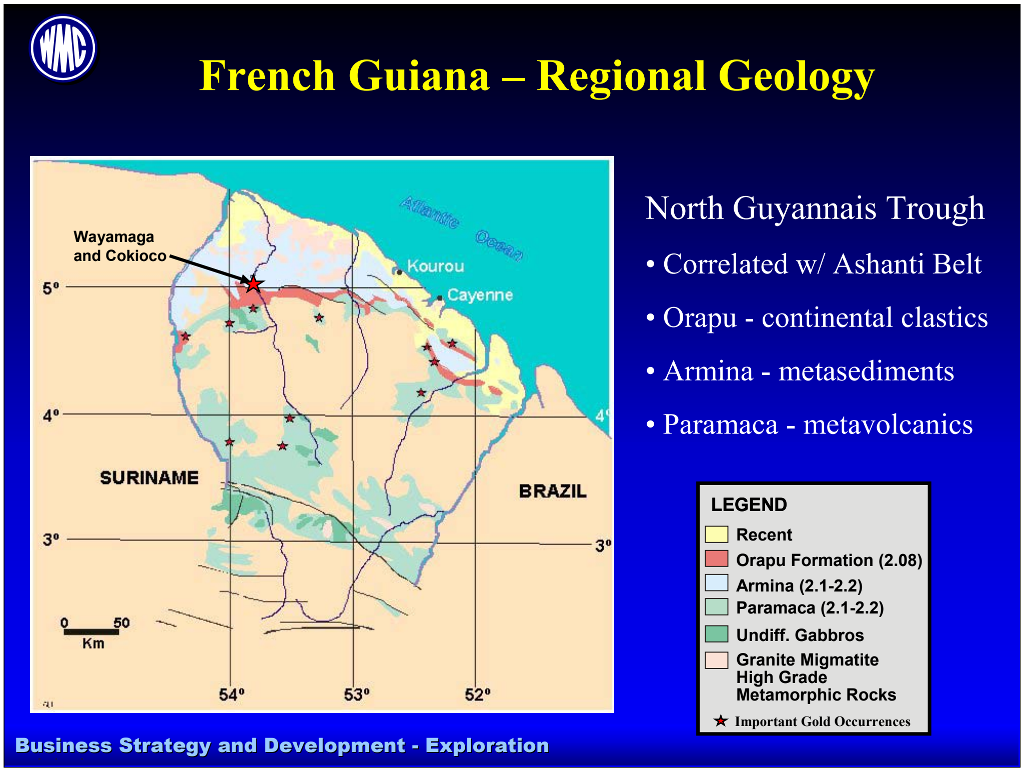


This is a summary map showing the result of the Auger drilling at Wayamaga and average Au grades in saprolite. The mineralized zone is shown by the dashed outline, defined by the high-grade intercepts shown by the symbols. Some of the better intercepts are 60m of 2.4 gpt with a maximum of 35 g, and 45m of about 3.5 gpt with a maximum of 16 g.

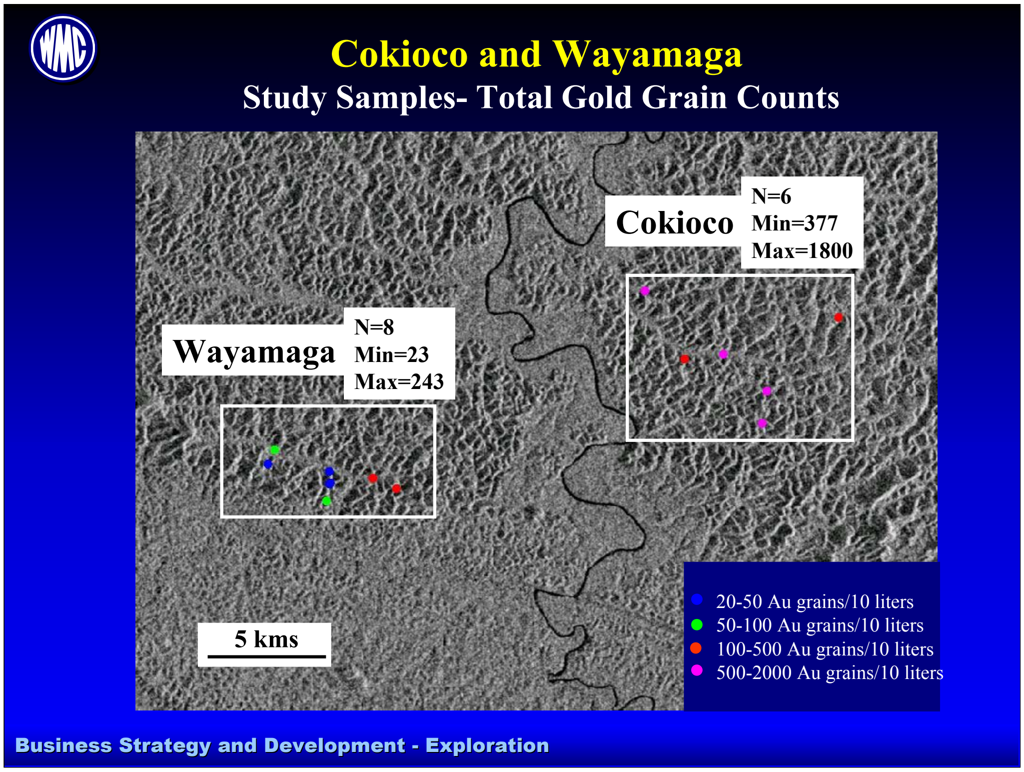


The northern part of South America has maintained an equatorial position for the last 200 my, with the last 140 my occurring under a tropical climate. The region is characterized by dense tropical rainforest with 1800 mm of ppt per year, and has a deeply weathered landscape including the development of laterites. The picture on the left shows the result of hydraulic placer mining on the Wayamaga property, all of which was done illegally by local miners. The photo on the right shows one of the hazards of locating your camp too close to the river.

There is very little infrastructure in northwest French Guiana, so all project work has to be supported by helicopter and boats. Because of this, exploration costs are extremely high.



The geology of the North Guyannais Trough consists of Paleoproterozoic sediments, metasediments and metavolcanics that correlate with the Ashanti belt in West Africa, which was rifted off of the South American continent during Cretaceous Time. The majority of the Au occurrences are located near structural contacts with the Orapu formation. The Wayamaga and Cokioco projects located here.



This is a radar image showing the two project areas. The contact between the Armina Formation to the north and the Orapu Formation to the south is clearly seen. Also shown are the sample sites used in this study, along with the total gold grain counts. Notice the extremely high counts for the Cokioco property compared to Wayamaga. We knew that it was better to be located near the structural break between the Armina and Orapu formations similar to Wayamaga, yet the amount of Au found in samples from Cokioco were so compelling that more than $1 million was spent trying to locate the lode source.

Cokioco vs. Wayamaga

	Cokioco	Wayamaga
Load Source	Not present (>$1 million)	Present (<1$ spent)
Placer Mining	Evident	Evident
Au Grains	V. Significant	Low
HMC Au	V. Significant	Weak
Stream Sediment Au	Significant	Weak
Stream Sediment As	Weak	Strong

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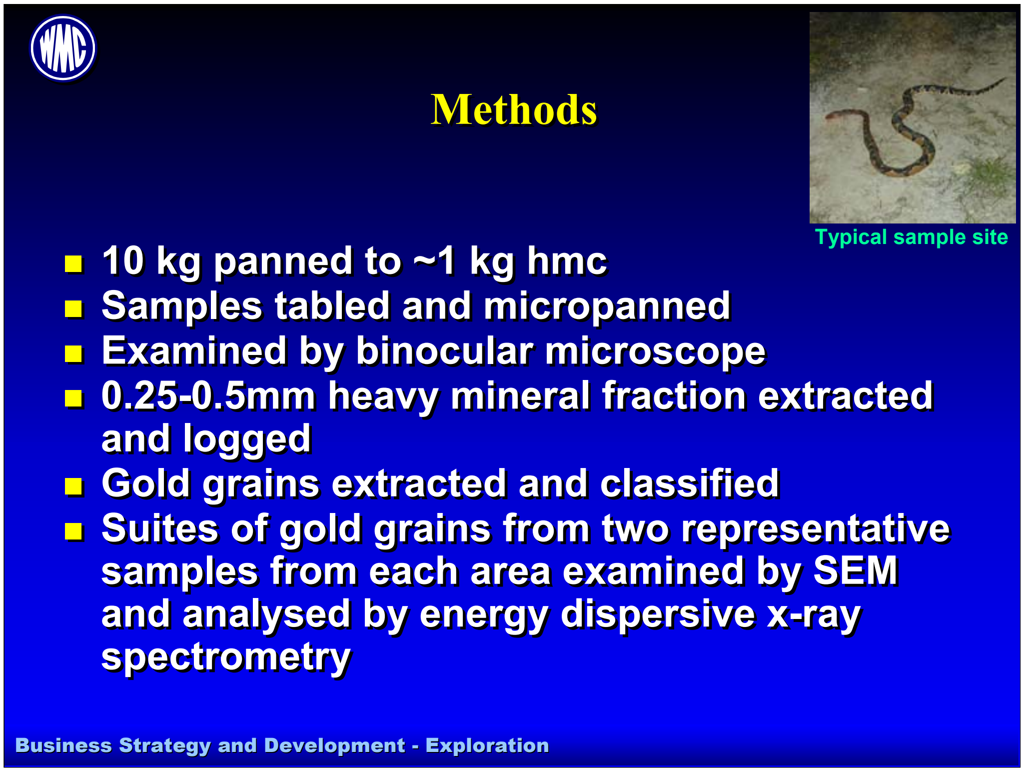
This table summarizes what we knew about Cokioco and Wayamaga before the study was conducted. Stream sediments, soil surveys, and extensive auger surveys at Cokioco failed to identify a bedrock source, whereas the same type of work at Wayamaga delineated a high-grade zone within saprolite over a strike length of 2 km. Placer mining is evident in both areas, although it is much more extensive at Wayamaga. As already mentioned, Cokioco has very significant accumulations of Au grains in sediment, which translates to high assay concentrations in both HMC samples and sediment samples. At Wayamaga, these were relatively weak, but there is a strong As response in stream sediments. We later determined that the As response was very important for regional exploration but less useful for follow-up surveys.



Fourteen samples were used in this study, 8 from Wayamaga and 6 from Cokioco. Each sample was tabled and micropanned and examine by binocular microscope. The HMC fraction was extracted and logged. Au grains were classified, and select representative suites were examined by SEM and analysed by energy dispersive x-ray spectrometry. All of this work was done at Overburden Drilling.

Results of Detailed Gold Grain Study
Cokioco vs. Wayamaga

	Cokioco	Wayamaga
Reshaping	Complete	Partial
Grain Size	125-300 um	50-150 um
Leaching of Ag	Complete	Thin or absent
Inclusions	Stable	Unstable

Other resistate minerals found in both areas:
ilmenite, xenotime, rutile, chromite and zircon;
no indicator minerals found

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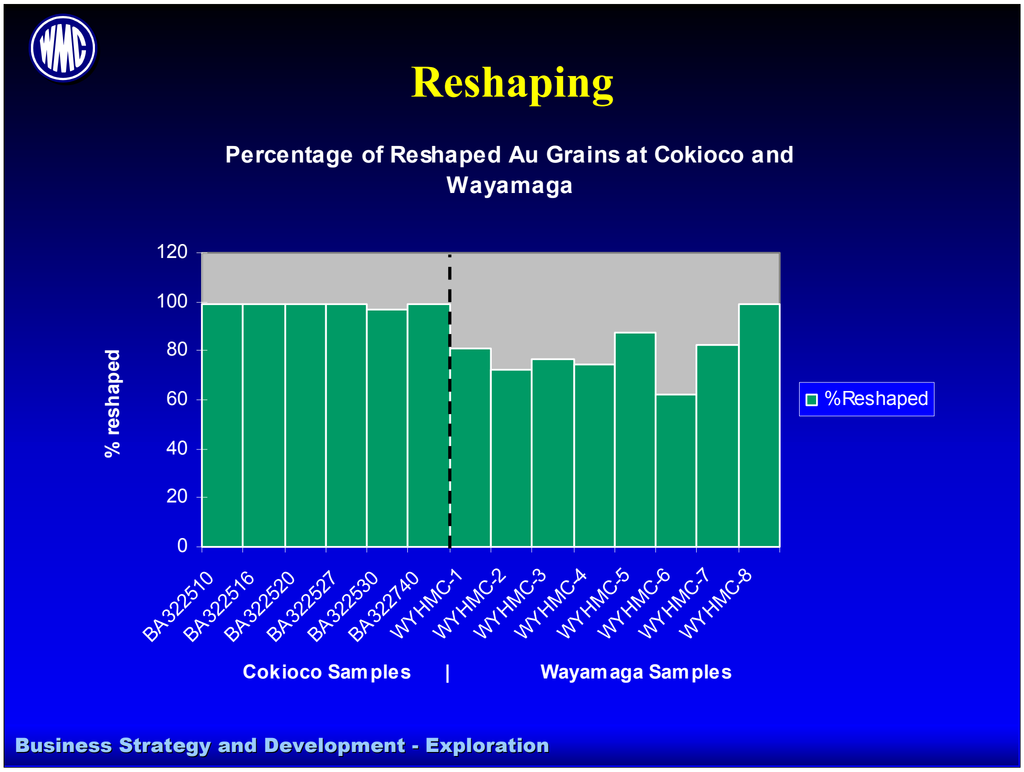
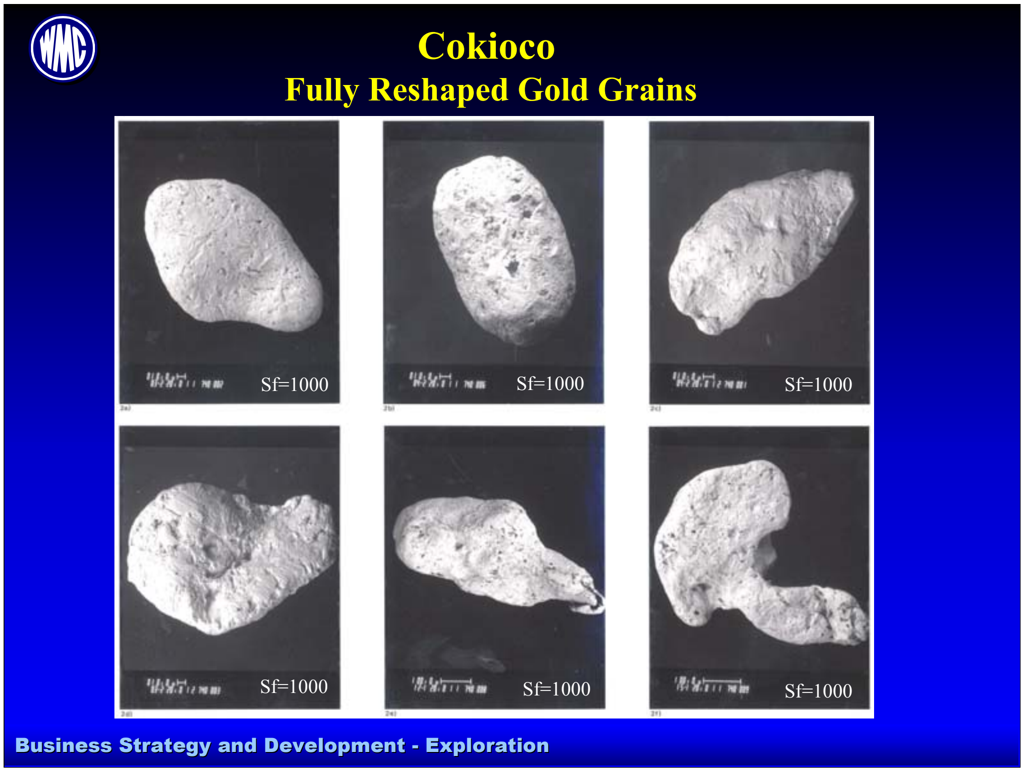
The results showed distinct differences between the two areas for the four categories shown here. Reshaping of the Cokioco grains was complete, with much higher roundness, flattening and folding observed in the grains. Wayamaga grains showed partial reshaping, but a high percentage of the grains showed original crystal faces and sharp angles. The Cokioco grains also have a higher average grain size, typical of mature placers. Leaching of Ag was complete in the Cokioco grains, including all surfaces and the interior cores of the grains. In contrast, leaching of Wayamaga grains was thin or absent, and the cores of most grains contained silver. Inclusions were rare in both areas, but where found, the Cokioco grains contained chemically stable inclusions and have the appearance of being entrained in the outer edges of the grains. In contrast, chemically unstable inclusions were found in Wayamaga grains, inside of the leached rims.

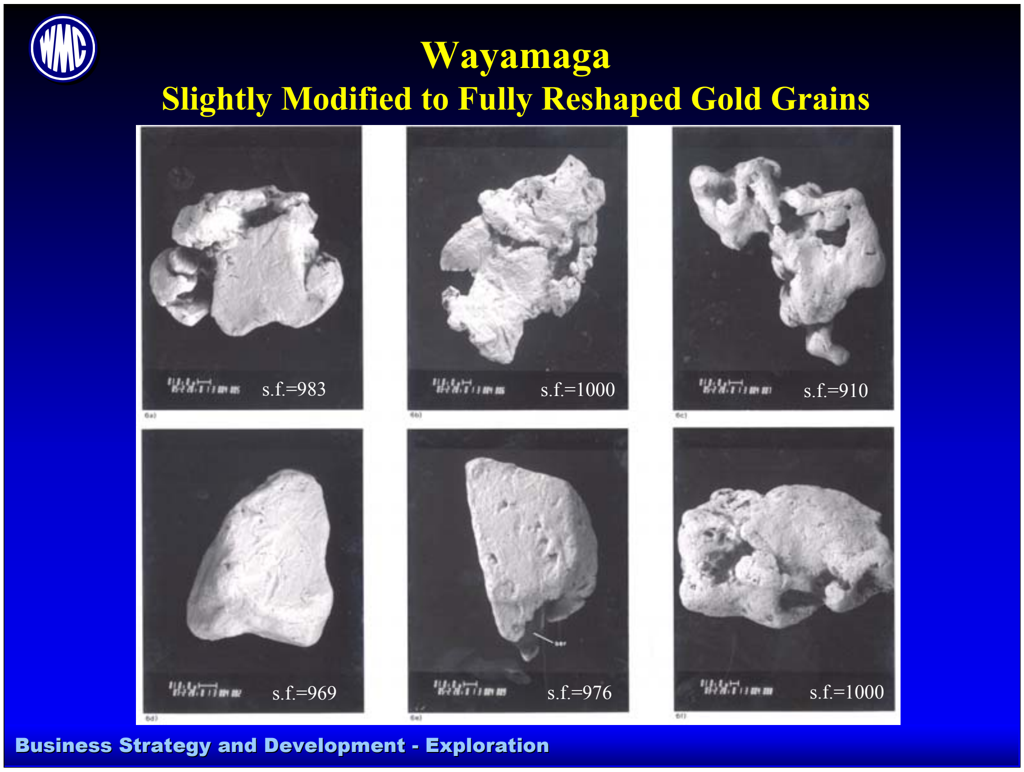
The heavy mineral fractions from both areas contained only resistate minerals and included ilmenite, xenotime, rutile, chromite and zircon. No indicator minerals were found.



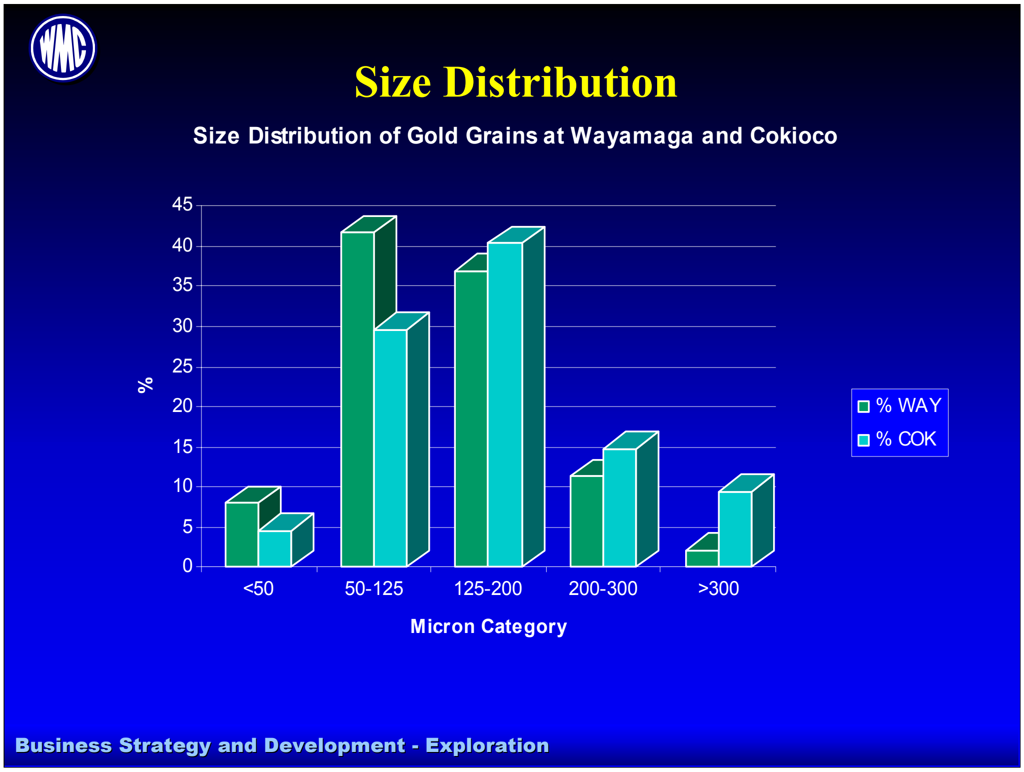
The percentage of reshaped grains for each sample is summarized in this graph. All of the samples from Cokioco show complete reshaping, whereas the Wayamaga samples show varying degrees of reshaping. The samples with higher amounts of reshaped grains reflect larger tributaries that have greater amount of sediment transport.



These are SEM backscatter images of representative grains from Cokioco. Notice that the grains are fully reshaped, have worn surfaces, and show no evidence of primary lode gold morphology. This grain also shows a tightly closed fold that was re-folded. This sample shows an atypical open fold, but this likely resulted from blockage from entrained sediment particles that have since fallen out.



In contrast, grains from Wayamaga are slightly modified, have open folds, and many show primary lode gold surfaces. In some cases, original crystal angles can be measured. This grain also shows included sericite, which is probably original gangue material.



This bar graph shows the size distribution of grains from each area by different micron size ranges. Notice the coarse bias of the Cokioco grains, shown in light green, compared to the Wayamaga grains. There may be some bias to these results from the more extensive placer mining at Wayamaga, but the results are consistent with other evidence that indicates that Cokioko is a mature placer environment.

Silver Leaching of Gold Grains

	Cokioco	Wayamaga
N =	59	56
Surface Fineness (average)	1000	988
Core Fineness (average)	1000	953

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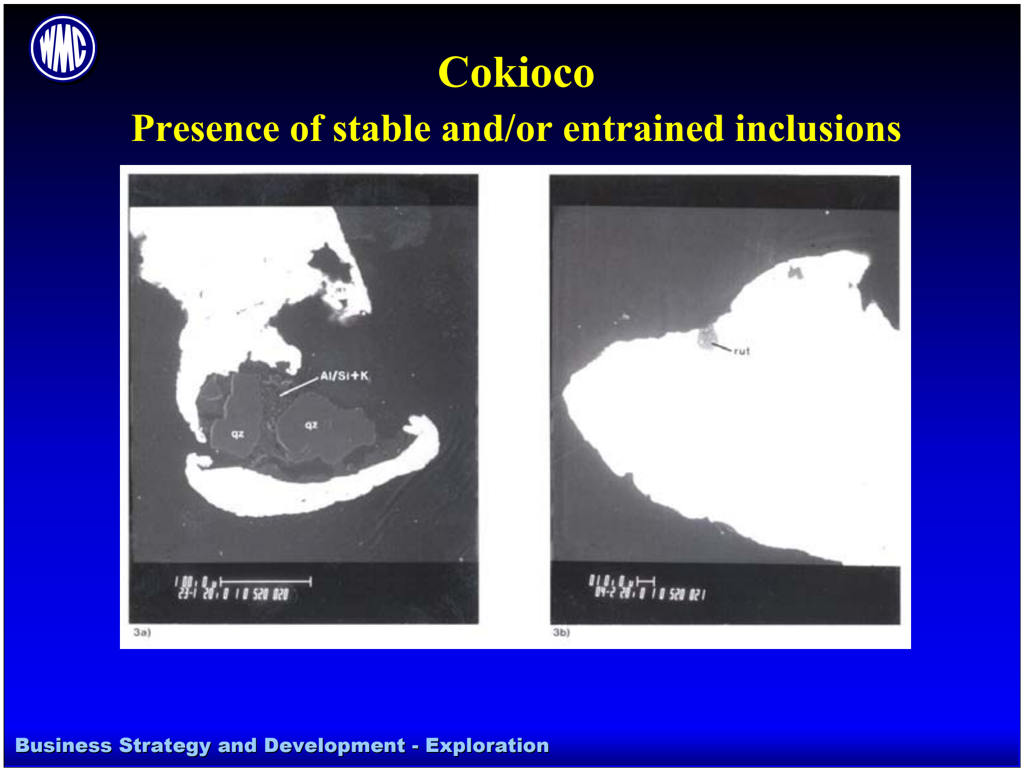
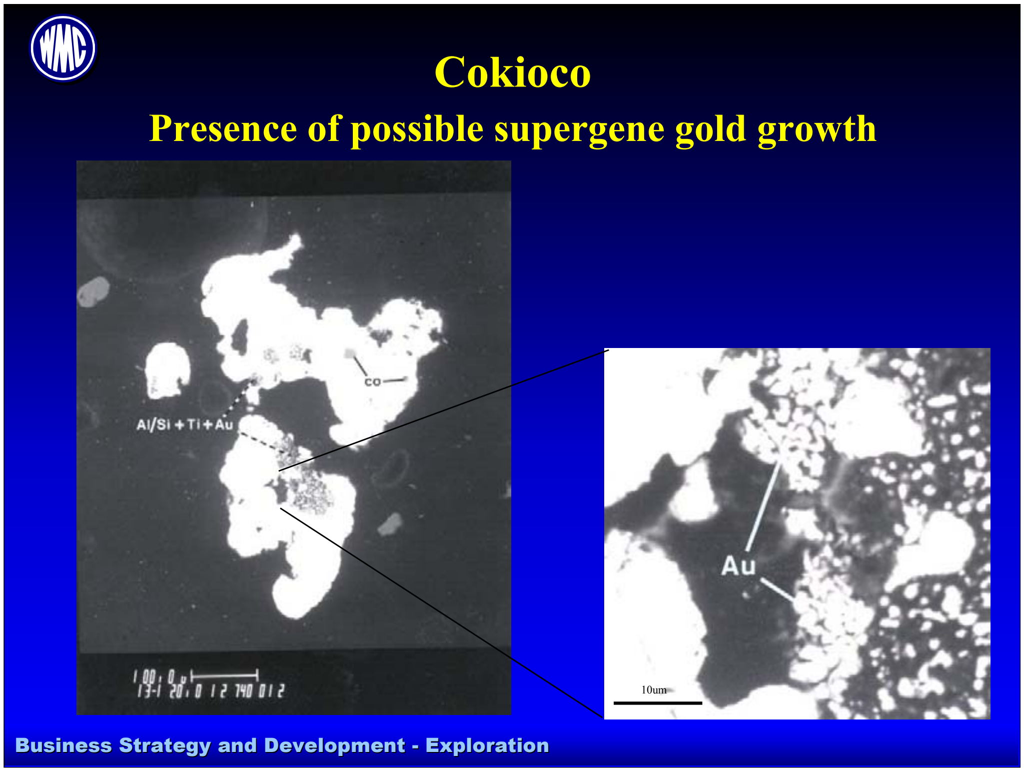
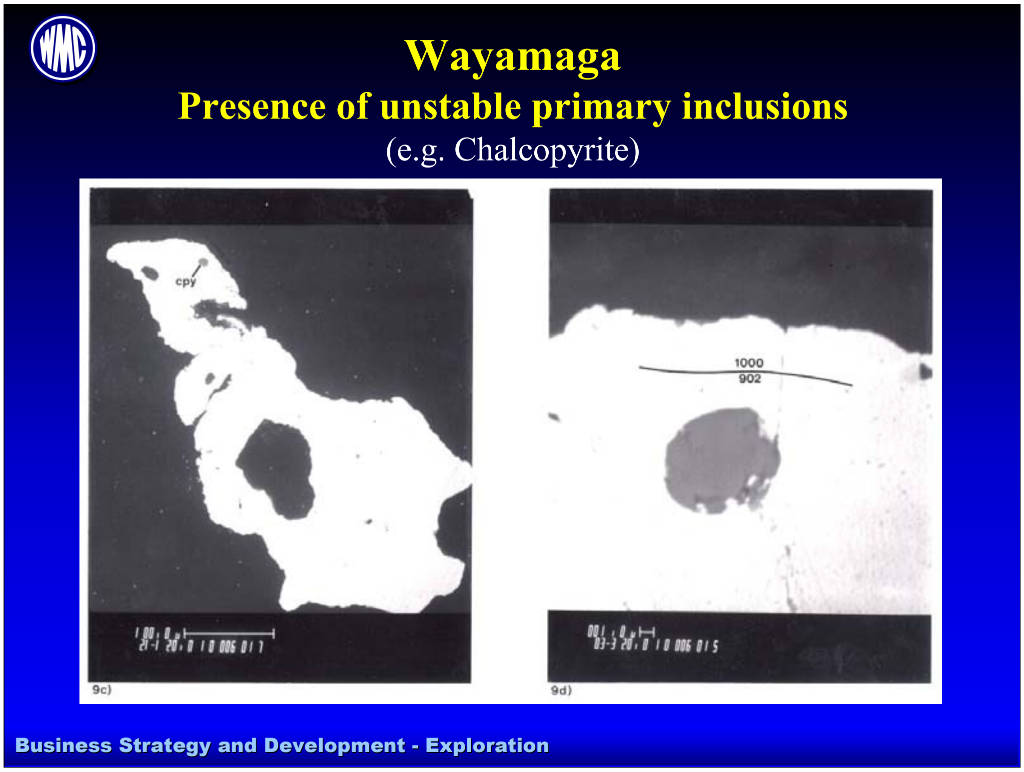
The degree of silver leaching can also provide some indication of the history of placer gold grains. In the case of Cokioco, leaching was complete, including all surfaces and the cores of the grains. Surface fineness from Wayamaga grains varied from 905 to 1000, and averaged 988. Core fineness was as low as 811, and averaged 953.



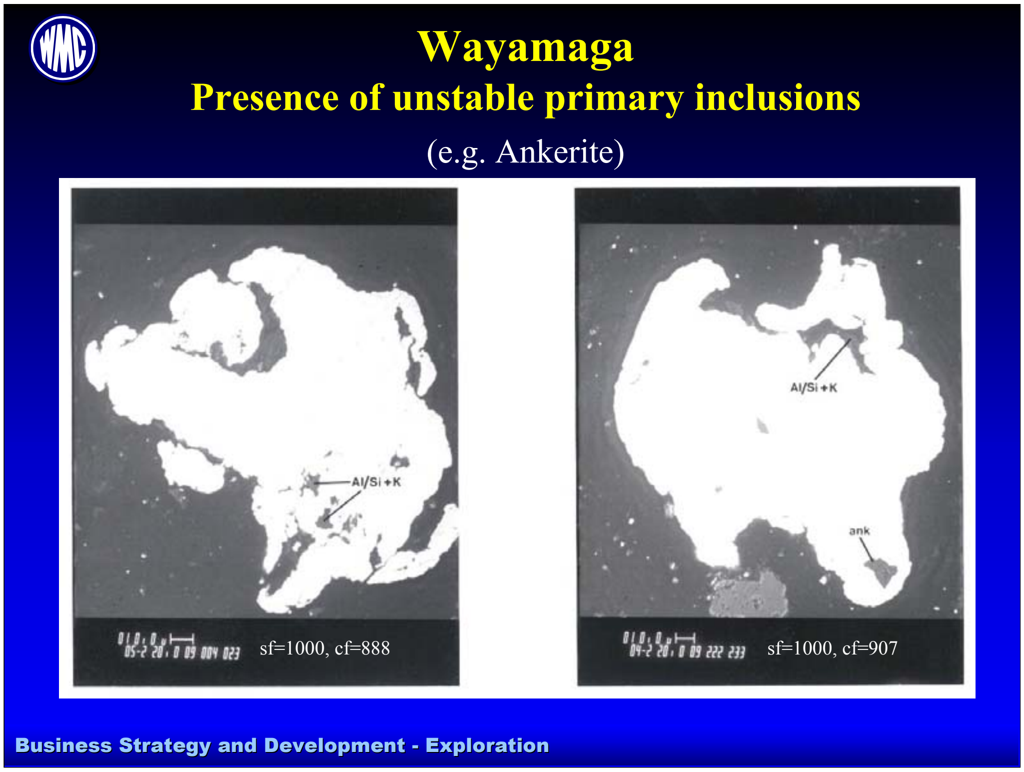
Inclusions within gold grains are rare from both areas. Inclusions from Cokioco are shown here, with the image on the left showing quartz grains and either clay or sericite occuring within a folded edge of the gold grain. The image on the right shows a rutile grain included along the edge of a gold grain. Both of these examples are interpreted to represent entrained particles from the stream bed. The fact that these included minerals are chemically stable and occur within gold grains completely leached of Ag supports this interpretation.



There is some evidence of supergene gold growth at Cokioco. A few samples showed fine-grained crystalline Au intergrown with a mixture of a Ti-bearing aluminosilicate mineral (scale on the right is 10 um). The gold has a wormy texture and a fineness of 1000. The image on the left also shows inclusions of cobaltite crystals with their preserved isometric crystal shape. They are surrounded by Au with a fineness of 1000, indicating their resistance to chemical weathering.



In contrast to Cokioco inclusions, those found in Wayamaga Au grains are chemically unstable and occur inside the low-Ag rim where the core of the grain is unaltered. The image on the left shows a chalcopyrite inclusion. This same inclusion shown in much higher magnification, is located just inside the pure Au rim.



Another example from Wayamaga shows potassium-bearing aluminosilicates and ankerite occurring inside the grains that have low fineness. These are interpreted to be original gangue minerals, and the occurrence of Au with sericite and ankerite represents a classic mesothermal gold association.

Mercury Contamination

Effects of Mercury on Gold Grains

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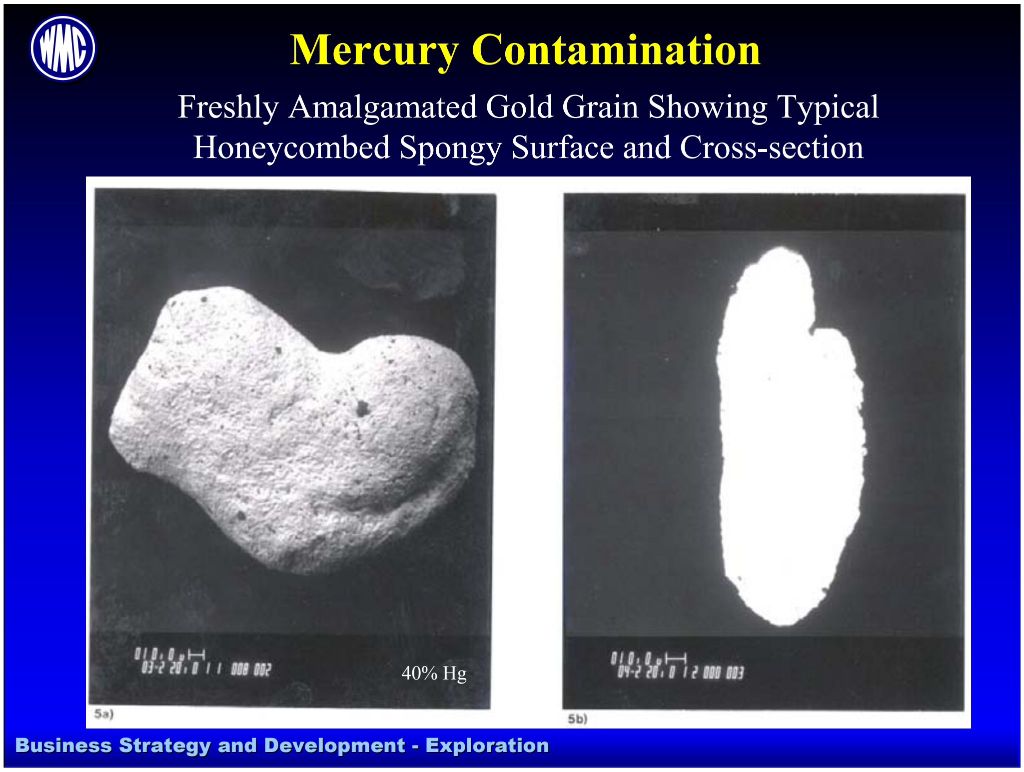
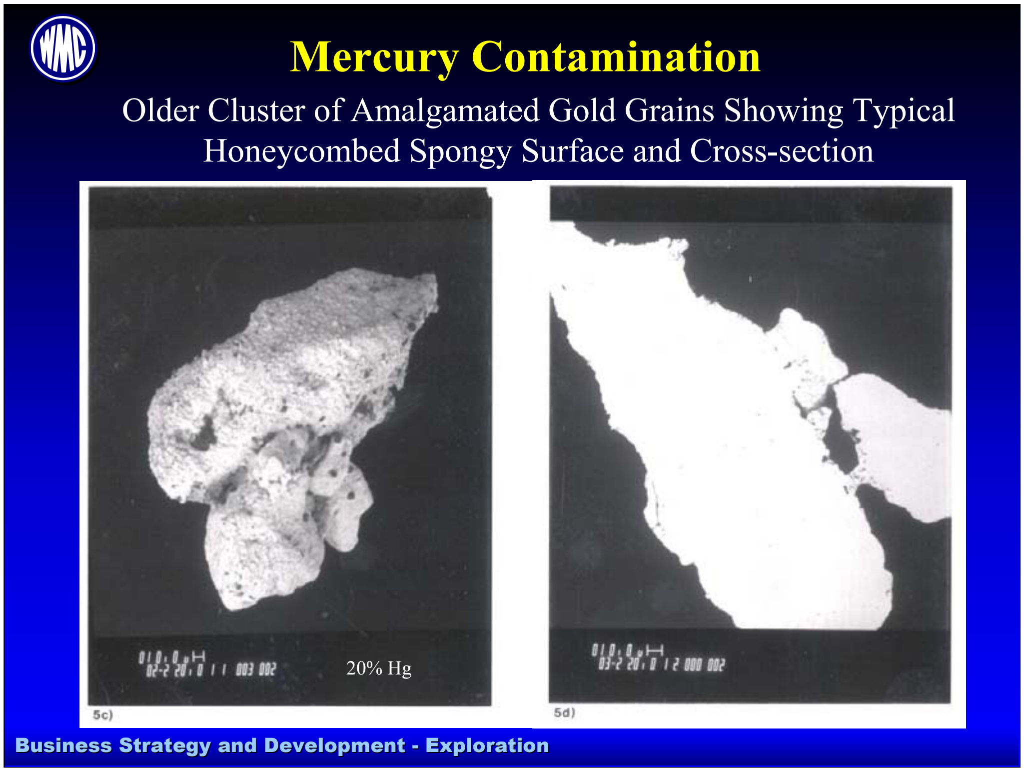
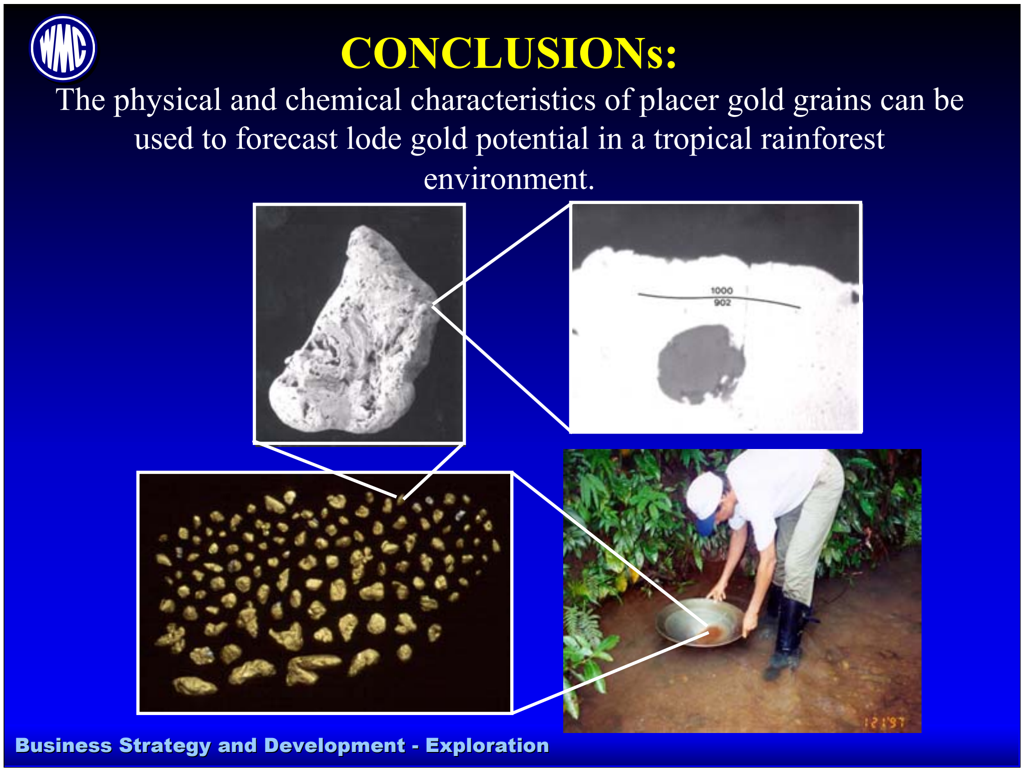
Hg contamination was documented during this study for environmental purposes and also to understand the effect Hg has on the Au grains. Trace amounts of contamination were found in Cokioco samples and Wayamaga samples had variable amounts, from nil to between 10-20 beads observed in the sample.



Amalgamation occurred in the stream bed and also during processing of the samples. Gold grains effected by Hg have a characteristic honeycombed spongy texture, visible on the surface and along the edges of the grain in cross section. This particular grain has 40% Hg and in some cases, the Hg penetrates the grain core. Grains such as this were not used in the study.



This last example shows gold grains that were amalgamated in the stream bed. Older amalgamated grains have a different color and more intense spongy texture due to vacant pore spaces from sites previously filled with Hg. In spite of the contamination, we were able to identify and eliminate grains effected by amalgamation.



The physical and chemical characteristics of gold grains are distinctly different between Cokioco, where the placers are overmature and the lode sources are completely eroded away, and Wayamaga, where the grains are being actively shed from a known lode source. It's likely that similar differences would be found in other tropical environments, but orientation surveys should always be conducted to confirm this. As few as six samples from a placer district can be used to characterize the gold grains and the potential for nearby lode sources. Assays on silt samples or panned concentrates are not enough to prioritize areas, and in fact, may erroneously focus the exploration to areas with the least potential for lode gold sources.

As you might expect, there were other key learnings from our work in French Guiana. Firstly, if you feel something crawling in your bed at night, you should probably check it out. Secondly, you need a big can of bug spray to work in the jungle. And finally, you can't trust Canadian geologists.