Quadrant II – Transcript and Related Materials

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Notes

MECHANICAL CONCENTRATION

Mechanical concentration is the natural gravity separation of heavy from light minerals through the agency of moving water or air. By this process the heavier minerals become concentrated into deposits called PLACER DEPOSITS. Two stages are involved: (1) Freeing of the stable minerals from their matrix by weathering, and (2) their concentration. Concentration may take place only if the valuable minerals possess the following three properties: (1) High specific gravity (2) Chemical resistance to weathering, and (3) durability (malleability, toughness or hardness). Some of the minerals which have these properties are: gold, platinum, cassiterite, magnetite, chromite, ilmenite, monzonite, zircon and gemstones.

The minerals that make up placer deposits may be derived from:

1) Commercial lode deposits such as gold veins.
2) Non-commercial lodes such as small gold- quartz or cassiterite veinlets.
3) Sparsely disseminated ore minerals such as minute grains of platinum sparsely disseminated in basic intrusive.

4) Rock forming minerals such as grains of magnetite, monazite and zircon.

In the formation of placer deposits, nature has operated to produce the results achieved by man when he mines, crushes and concentrates ores. First the placer minerals are released from their matrix by weathering. Next, the materials are washed slowly down slope to the nearest stream or to the sea shore. Finally moving stream water sweeps away the lighter matrix, leaving the heavier placer minerals closer to the source. Waves and shore currents also separate heavy minerals from light ones and coarse grains from fine ones. From thousands of tons of debris, a few heavy minerals in each ton are gradually concentrated in the stream or beach gravels until they accumulate in sufficient abundance to constitute placer deposits.

The operation of mechanical concentration rests on a few basic principles involving mainly the differences in specific gravity, size and shape of particles, as affected by the velocity of a moving fluid.

1) In a body of water, a heavier mineral sinks faster than a lighter one of the same size. Moreover, the difference in specific gravity is accentuated in water as compared to air.
2) The rate of settling in water is also affected by the specific surface of particles. If we observe two spheres of the same weight but different size, the smaller one, with its lesser surface and therefore lesser friction in water, is seen to sink more rapidly.
3) The shape of a particle affects its rate of settling. A spherical pellet has less specific surface than a thin platy disc of the same weight and therefore sinks more rapidly.
4) The ability of a body of water to transport a solid varies as the square of its velocity. When the velocity doubles, the transporting power is increased four times and stationary materials are moved. Conversely, when the velocity is halved, much of the transported load is dropped. Hence placer minerals may be dropped where the current slows down. Specific surface also plays a part: Of two

equal weight particles, the one with the larger specific surface is moved more rapidly with increased water velocity.

5) A suspended particle is moved more rapidly by a flowing fluid than another particle at rest. Thus eddies in streams or shore currents raise particles from the bottom and enable the current to sweep them away.

For the mechanical concentration of placer minerals, the velocity of water must be favourable. If too low, the lighter minerals will not be removed from the heavier ones. If too great, the placer minerals will also be swept away and perhaps dissipated. A slackening of velocity causes deposition and accumulation. In a stream a change of gradient, meandering, spreading or obstructions all produce reduced velocity and permit heavier minerals to drop and accumulate.

It is essential that a continuous supply of placer minerals be made available for concentration. Thus the most favourable regions are those of deep weathering and topographic relief; weathering frees the placer minerals and relief permits the debris of weathering to move towards the stream or beach. A plateau or peneplain cannot supply debris.

ELUVIAL PLACERS: These are formed without stream action, upon slopes from materials released by the weathering of lodes that outcrop above them. The heavier resistant minerals collect below the outcrop and the lighter non-resistant products of decay are dissolved or swept down-hill by rain-wash or are blown away by wind. This brings about a partial concentration by reduction in volume and the process continues with progressive downward creep.

Fairly rich lodes are necessary to yield workable deposits by this incomplete concentration. The most eluvial deposits are those of gold and tin.

STREAM OR ALLUVIAL PLACERS: These are by far the most important type of placer deposits. They have yielded the greatest quantity of gold, tin, platinum and precious stones.

Flowing water is the most effective separator of light from heavy materials. While rushing through canyons it sweeps everything along. It swirls around the outside of bends (concave banks) and creates eddies that pick up bottom material. It slackens in wide places and on the inside of the bends (convex banks) and drops heavy substances.

During dry seasons the stream velocity is low and the placer minerals remain at rest. But in flood time they are swept farther downstream together with enclosing gravels and re-concentrated on bars, stream margins of flood plains or other favourable places.

The lower sluggish parts of streams are not favourable sites for placer accumulation. And neither are the upper head waters because of the limited supply of source materials. The most favourable sites are the middle reaches.

In a rapidly flowing meandering streams, the fastest water is on the outside curve and slack water is opposite i.e. on the inside curve. Gravel bars form at the junction of the two and this is a favourable site for the accumulation of placer minerals.

Where the stream crosses highly inclined or vertically layered rocks, such as slates, schists or alternating hard and soft beds, the harder layers tend to project upward and the softer ones to yield depressions. This produces natural riffles which are excellent traps for placer minerals.

The mode of entry of the placer minerals into a stream also determines the site of accumulation. Where material is brought in by a swift tributary into a slower master stream, they accumulate as a pay streak down the near side due to diminished velocity. If a stream crosses a mineralized lode and supplies, the placer minerals through its own erosion, the pay streak will be spread across the channel on the downstream side of the lode.

Placer accumulation requires well graded streams, where a balance has been reached between erosion, transportation and deposition. The best concentration is yielded by moderate gradient in the vicinity of 1: 170 or around 6metres/ kilometre.

PAY STREAKS: A pay streak is a linear patch of rich ore within a placer deposits. Gold tends to occur in concentrated pay streaks which are likely to be narrow and rich. The coarser gold is deposited in the upper reaches and the finer gold in the lower reaches of a stream. A pay streak is generally irregular in outline. It branches and splits and is absent in certain places. Although a definite pay streak may be present, some gold is generally found scattered throughout the main body of stream gravels. Pay streaks draw the attention of prospectors and happen to be the earliest mined portions especially by manual methods.

BEACH PLACERS: These are concentrations of ore formed along seashores by the concentrating effects of wave and shore action. Shore currents shift materials alongshore and the lighter ingredients are moved faster and farther than the heavy ones, thereby concentrating the heavy minerals. Wave action operates at the same time. Pounding waves throw up materials on the beaches, the backwash and undertow carryout the lighter and finer material which in turn is moved alongshore. The larger and heavier materials are concentrated on the exposed beaches.

Placer minerals may be made available for beach concentrations by (1) streams that flow on to the coast, (2) wave erosion upon sea terraces or gravel plains (3) wave encroachment upon former near shore stream terraces and (4) wave erosion of rocky shores.

Placer minerals of beach deposits consist of gold, ilmenite, magnetite, diamonds, monazite and zircon.

Beach gold is mostly very finely divided and gives evidence of the travel and beating it has undergone. Ilmenite and monazite have undergone unusual beach concentration in Kerala where sands contain 50 – 70% of Ilmenite, 2 – 25% of monazite along with zircon, garnet and other minerals. Brazilian beaches contain very high concentrations of zircon. Beaches in Australia contain as much as 75% zircon.

One of the most remarkable beach concentrations is that of diamondiferous gravels of South Africa which in one year 50 million dollars. The diamond occurs in marine gravels which extent intermittently for a distance of 320kms. The diamonds are thought to have been carried down by the Orange River and to have been distributed down to the coast by the prevailing southerly shore currents and by waves.

EOLIAN PLACERS: When wind acts as the agent of concentration, the resultant deposits are eolian placers. Obviously this can occur only in arid regions. Some eolian gold placers have been formed in the Australian deserts from the disintegration of gold-quartz lodes. The lighter decomposed materials have been blown away. Thus the heavy gold particles, freed from their matrix, are left behind. The continuous operation of this process finally resulted in patches of surface accumulation of placer gold in a debris and wind-worn pebbles. Some of this gold was recovered by “dry washing” i.e. by utilizing wind instead of water to separate the debris from the gold after screening off the pebbles.