<u>Gravel transport</u>

The addition of gravel tends to **armor**, or **pave**, the bed. That is, the upper surface of a bed takes on increasingly coarser particles. Experiments also confirm the **hiding** influence of coarse grains. That is, sand in flow is less mobile in uniform bed than when it is surrounded by coarser gravel.

Pure sand-bedded streams, as a rule, do not exhibit these characteristics. There have been two conflicting explanations of how these processes manifest themselves => the equal-mobility wars.

Selective transport (Komar, 1987)

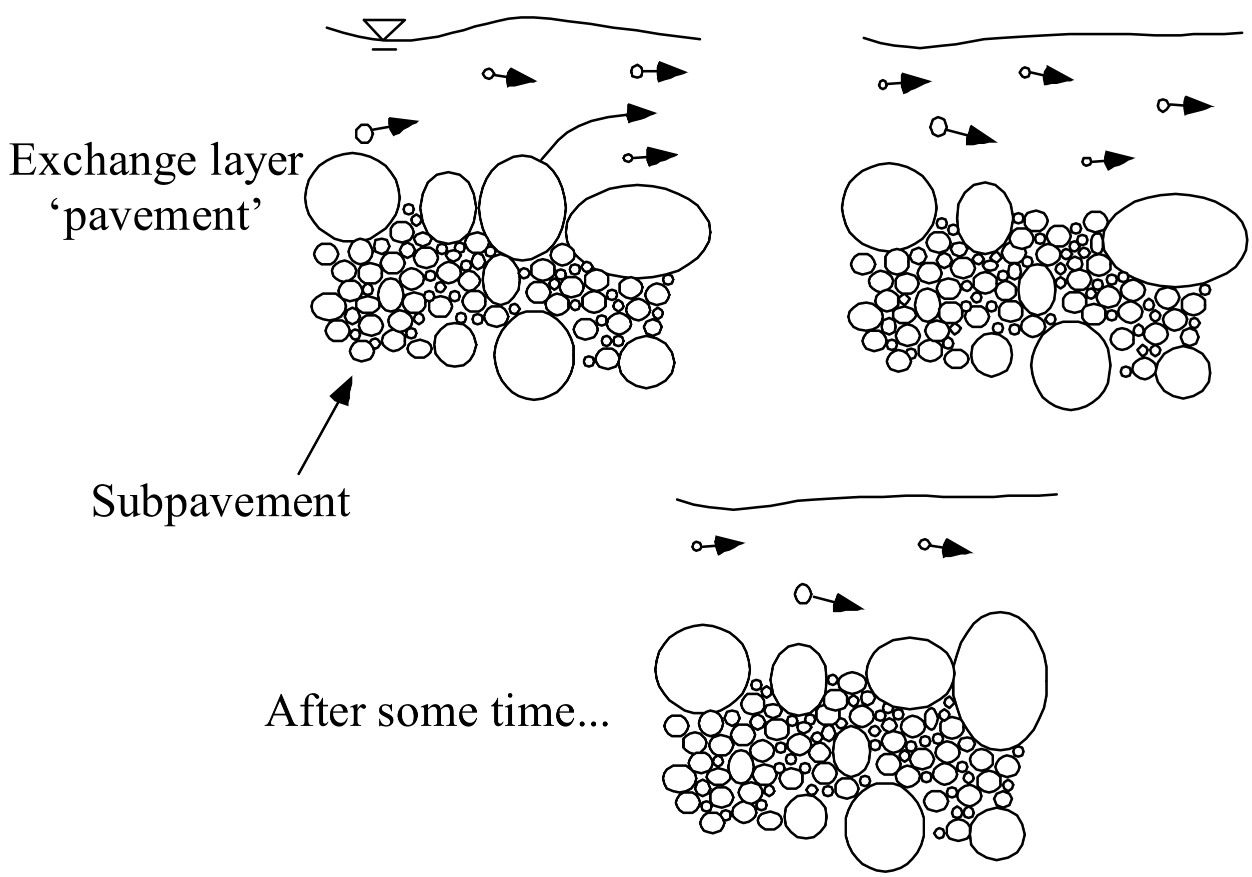
Finer sediment is winnowed away because of its increased mobility. Though Komar (1987) admits hiding does occur, he suggests that it does not overwhelm the relationship revealed by the Shields curve – that in a DIMENSIONAL sense, coarser particles require more shear stress to resuspend than finer particles.

He uses evidence based upon placers in sand and indicates that oversized material is resistant to movement, unlike finer material.

This method implies that the coarsest fractions in a flow are generally never mobile. If they were, then a pavement should not exist at high flow times. It would reform with time because of selective transport.

Equal mobility (Parker and Klingeman, 1982; Parker et al., 1982)

The ‘exchange layer’ of a bed adjusts until there is enough coarse material to ensure that it (the gravel and cobbles) is as ‘equally mobile’ as finer particles. Parker and colleagues insist there is a dynamic interaction between movement of the surface layer and finer sediments, which has the effect of burying finer sediments.



Formally, the equal mobility hypothesis states:

$$f_i = p_i \tag{1}$$

where f_i is fractional content of the ith size range in the substrate and p_i is the fractional volume of the bedload in the ith size range.

Another important aspect of the assessment of equal mobility is the proper choice of the relative transport rate. Parker uses:

$$\frac{W^*}{W_r^*} = G\left(\frac{\tau^*}{\tau_r^*}\right) \tag{2}$$

where W^* is the dimensionless transport rate and W_r^* is a reference dimensionless transport rate. G is an arbitrary empirical function (Parker, 1979). Parker and Klingeman (1982) showed that $W_r^* = 0.002$ fit models constructed from both laboratory and field data well (MPM, Einstein, etc.).

Parker and colleagues showed that:

$$W_i^* = \frac{Rgq_{Bi}}{f_i u_*^3} \tag{3}$$

is nearly identical for all size fractions and you can therefore use the geometric mean in place of all of the size information.

As a result, we can find the total bedload transport rate quite easily:

$$W* = \frac{Rgq_{Btotal}}{{u_*}^3} \quad (4a)$$

where

$$W* = 0.002G\left(\frac{\tau_{50}*}{\tau_r*}\right) \quad (4b)$$

You can also back-calculate the relative content of the pavement (see Parker and Klingeman, 1982, for details).

According to Parker (1990), many unsteady flows (i.e., beds which are not in equilibrium) can exhibit selective transport, and therefore deviate from (21). However, he suggests that selective transport is merely the way the exchange layer develops towards a steady-state.