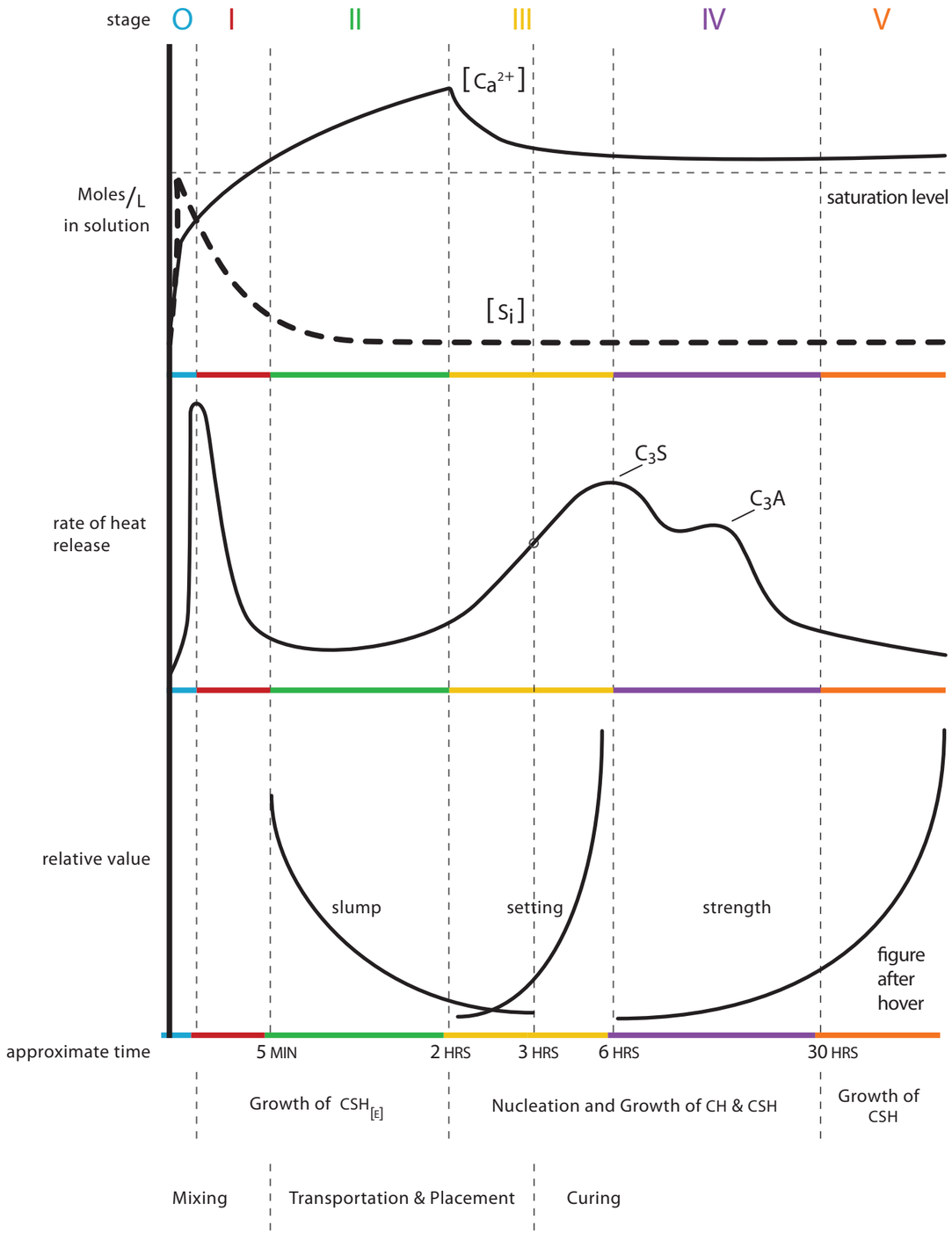

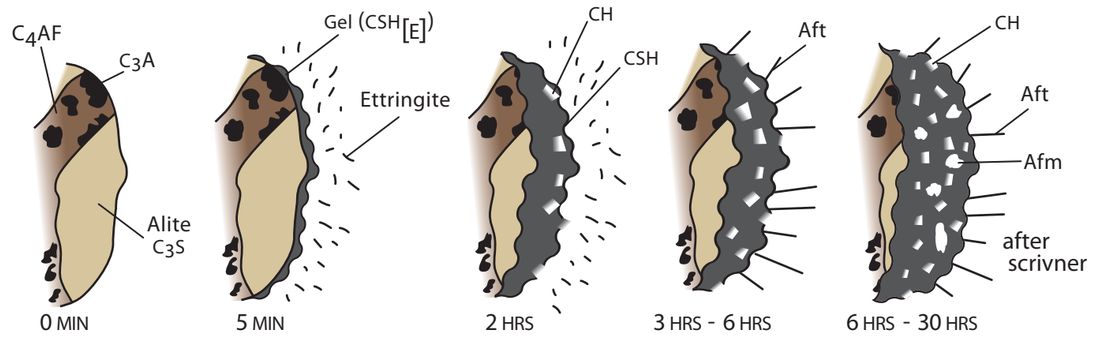

Stage 0

Cement is added to water

Large amount of initial dissolution and reaction (Hydrolosis)

$C_3S + H_2^{(u)}O \rightarrow 3Ca^{2+} + 4\,OH^- + H_2SiO_4^{2-}$

Ca^{2+}; O^{2-}; SiO_4

$C_3A + 3C_sH_2 + 26H \rightarrow C_6AS_3H_{32}$

Gypsum — Ettringitre

Ca^{2+} Increases

SiO_4^{2-} Decreases

Stage I

Surface of cement particle "changes"

Surface chemistry (or charge) may change

Cement grains may be covered in an early CSH or gel material. It becomes difficult for water to access the cement grains.

Stage II

Induction Period

Very little heat is given off

Ca^{2+} concentration continues to increase

Still difficult for water to reach the cement grain

Stage III

Ca^{2+} concentration becomes super saturated and CH forms

Surface of cement grain "changes"

Ca^{2+} buildup may change surface chemistry

CH nucleation may break down surface

Osmotic pressure may break down initial CSH

CSH is formed rapidly

Ettringite nucleates on surface and initial set occurs.

Stage IV

Hydration slows as CSH forms on the surface of the cement grain and water cannot easily access cement grain. The reaction becomes diffusion controlled.

Stage V

Hydration proceeds at a slow rate as long as water is available

Hydration will cease if the water is removed from the system! This is why curing is so important!

Portland Cement Hydration By Tyler Ley, PH.D, P.E.

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