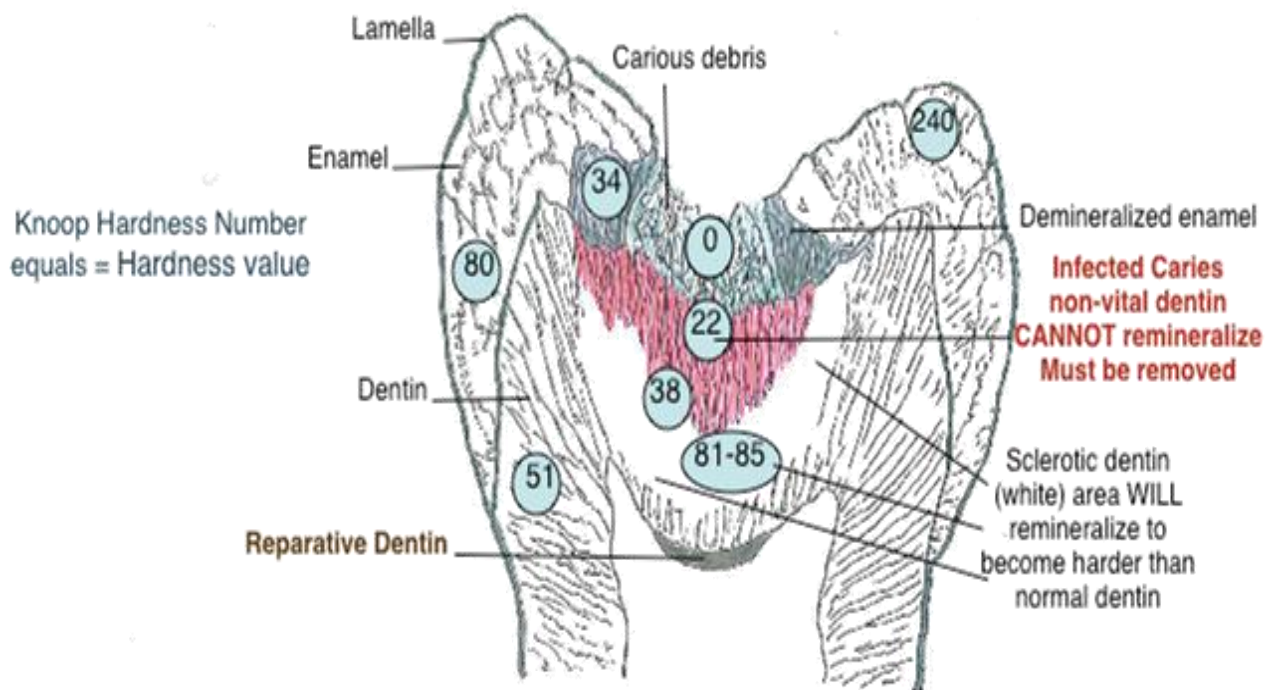


DiscovRED Factoid

HUMAN CARIOUS DENTINE IS COMPOSED OF TWO DISTINCT ZONES

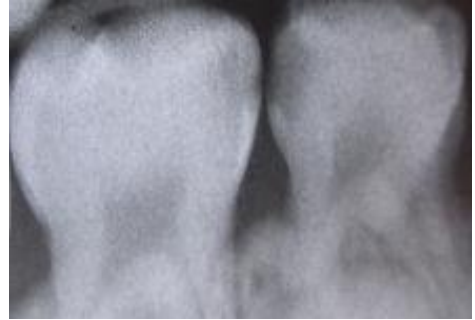
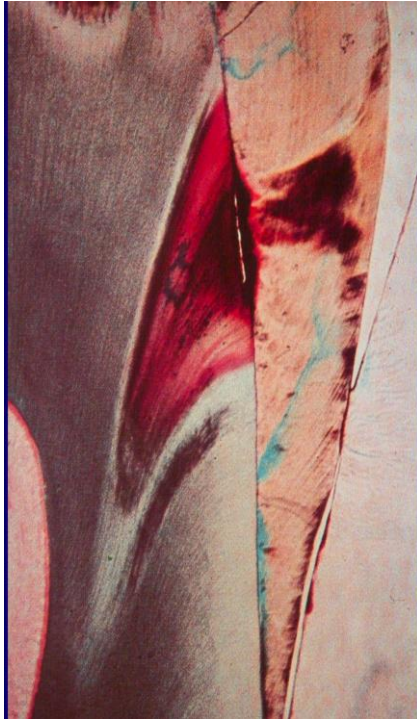
INFECTED DENTINE – is the **outermost zone of carious dentine** that lies directly under the enamel. It is a **completely dead** zone of infection having completely lost all minerals & proteins (collagen, proteoglycans, glycosaminoglycans, etc). The necrotic tissues **must be removed from the cavity—or the pulp may die**. **Aerophilic** (*Strep mutans* & *Lactobacillus*) bacteria are 1st to invade the tooth to cause demineralization of all the enamel minerals. The 2nd invasion of bacteria are proteolytic forms of **Facultative** *Pseudomonas* & **Anaerobic** *Bacteroides* that completely destroy all proteins (collagen, GAG's) to create a dead zone that must be removed before restoration is completed.



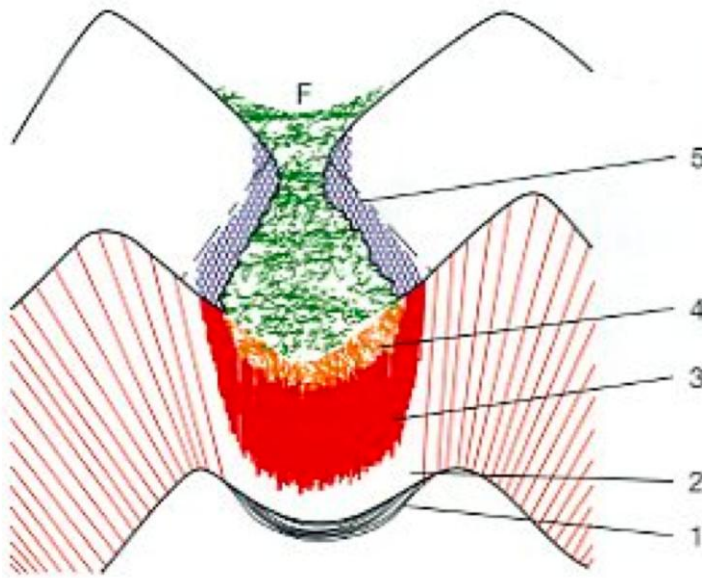
Hardness values of **infected caries** dentin is low - from 19 to 34 KHN

The remineralized **sclerotic dentin** is between 81 to 85 KHN

AFFECTED DENTINE—is the **deepest layer of carious dentine** that lies towards the vital pulp of the tooth. It is a demineralized zone, devoid of most minerals, leaving the vital proteins of the dentine substrate essentially vital & unaffected. These vital proteins provide a framework of collagen that **permits re-mineralization**. From a clinical standpoint, this zone should be left in place to become remineralized. The 1st invasion of bacteria into this layer is aciduric aerophilic types (*Strep mutans*, *Lactobacillus*), which give off organic acids that demineralizes the minerals.



Controlled caries removal studies *in vitro* & *in vivo* MINIMAL INTERVENTION have shown that the **outer infected dentine must be removed**—it is **biologically advisable to leave the deepest affected dentine undisturbed, so as to permit it to remineralize**. In the 1880's, Dr. Fish observed that portions of dentine (peritubular dentine) collapsed to become redeposited as nano-crystals, which then obstruct the dentinal tubules with a new plug of calcium hydroxyapatite crystals that block fluid flow—Dr. Fish named **this remineralized zone—sclerotic dentine**. This biological blockage of nano-crystals is known to **prevent dentine hypersensitivity** & to **prevent penetration of bacteria** towards the vital pulp. Otherwise, bacteria & their toxins would cause pulp cell death, inflammation, eventual pulp necrosis & likely periapical pathology with severe bone loss & extraction.



- 1) **REACTIONARY or REPARATIVE** dentine forms when the original odontoblastic cells become damaged or lost. New odontoblastoid cells deposit a layer of new reparative dentine that forms a **biological barrier** against insults from the bacterially infected carious tissues & their damaging components.
- 2) The **white zone** of dentine is called **sclerotic** dentine—filled with mineral nano-crystals that block the fluid flow against patient hypersensitivity & bacteria.
- 3) The **dark red zone** is **affected carious dentine**—a deeper zone of caries that has lost its minerals. The collagen & other **proteins of this zone are vital** & should be left in place to allow remineralization with new nano-crystals.
- 4) The **orange zone** is **infected carious dentine**—a more superficial zone that has lost both its mineral components as well as all of the organic proteins. It is a dead tissue & must be removed before restoration.
- 5) The **blue-gray zone** is demineralized enamel—packed with bacteria—that must be completely removed before restoration with a restorative agent.
- F) The **green zone** is bacterial biofilm, composed of many organisms that are aerophilic & anaerobic. These bacteria are opportunistic—they become very active if they are fed sugars & carbohydrates—caused by a lack of oral hygiene such as brushing & flossing by the patient, especially if the patient fails to maintain their own proper dietary habits.

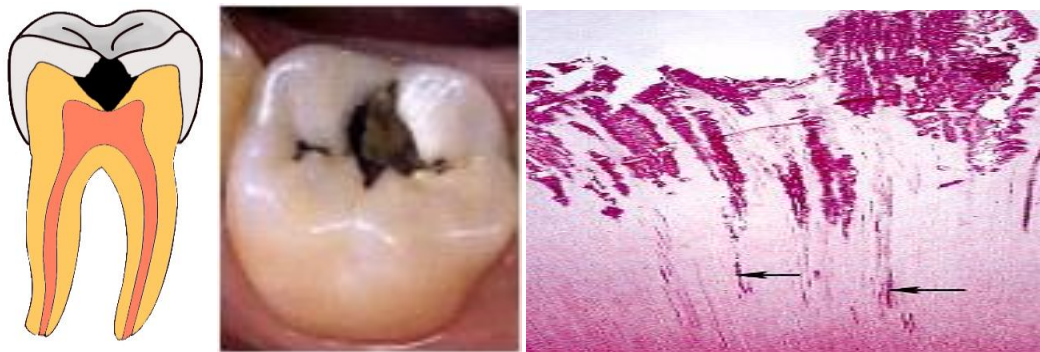
Clinicians make rapid clinical-chairside decisions. How can they selectively remove **outer infected caries dentine**?—Leaving the **deeper affected demineralized zone** to remineralize around the vital collagen-proteins. This sclerotic dentine is the tooth's normal biological response to reinforce the dentine under the original carious lesion. The clinician's solution is to use the non-toxic stain—**DiscovRED**—to differentiate **INFECTED** dead carious dentine from the **NORMAL** & **AFFECTED** vital dentine.

IDENTIFICATION & DETECTION OF INFECTED CARIOUS DENTINE

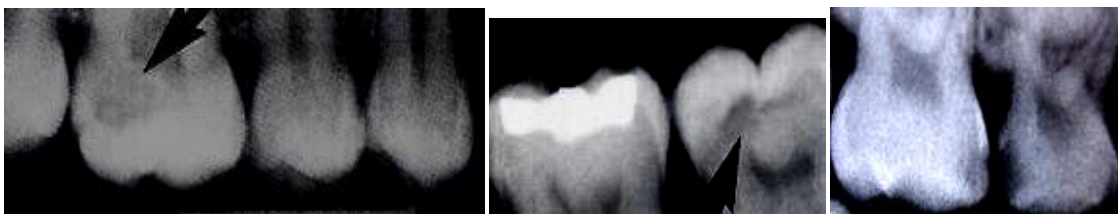
Caries is a bacterial infection presenting **two zones** of activity. The **deepest affected zone** (towards the pulp) contains organisms that produce acids that demineralize both enamel & dentine—leaving the proteins intact. The **superficial infected zone** is **dead tissue** that must be removed! The normal unaffected-noncarious dentine should be left in place.



Historically, clinical caries (decay) was observed by eyesight using daylight from windows & reflecting mirrors—usually with a southern exposure. Later, electric lights focused light to the tooth to permit the clinician to identify debris & decay for removal. Jeweler instruments were used to scrape the cavity debris along with various cutting burs to shape the cavity so as to hold the restorative agent in place.



In the early 1900's, clinicians used X-rays to identify the penetration of caries into enamel & dentine. Consequently, they were able to remove caries in interproximal areas between teeth, which until then had been unseen by clinician's eyes.



Initial enamel caries is seen as a **white spot lesion**—unseen by caries dye.



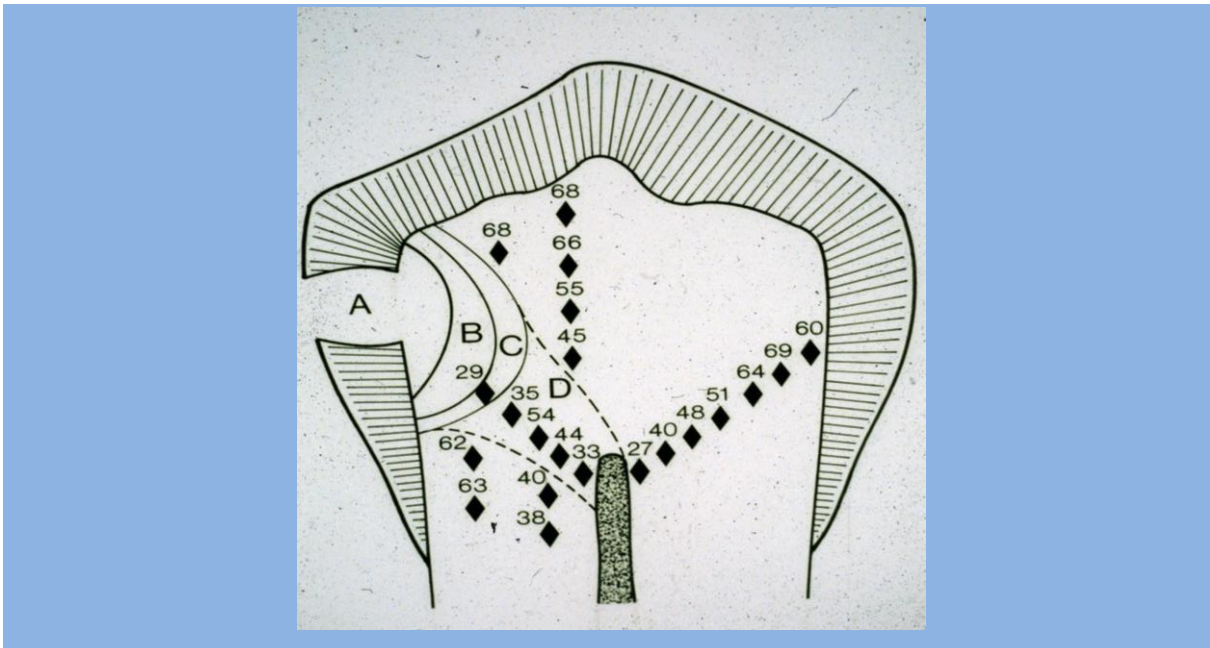
As **dentine becomes infected**, the colors change—initial caries is light yellow then to dark yellow & to light brown & to darker brown & to green & to black.

The colored areas present different degrees of caries progression and hardness.

White→light yellow→dark yellow→light brown→dark brown→green→black

The question remains—How can the student learn to subjectively remove only the infected caries---while leaving affected & normal dentine untouched?

KNOOP-HARDNESS VALUES OF CARIES



The carious lesion is seen above.

Non-carious normal dentine can show a wide range of KHN values.

Zone A is very soft @ 0-KHN value—is easily removed with a hand curette.

Zone B of infected dentine @ 28-KHN is completely demineralized—all proteins are dead—they stain with **DiscovRED** & are easily removed with a low speed bur.

Zone C of affected dentine is @ 38-KHN may only lightly stain & may be left as the proteins supports its remineralization into a dense sclerotic dentine around 68-KHN.

The **sclerotic zone below C** has **higher than normal dentine** values that range between 62-68 KHN. **Sclerotic dentine is harder than normal dentine!**

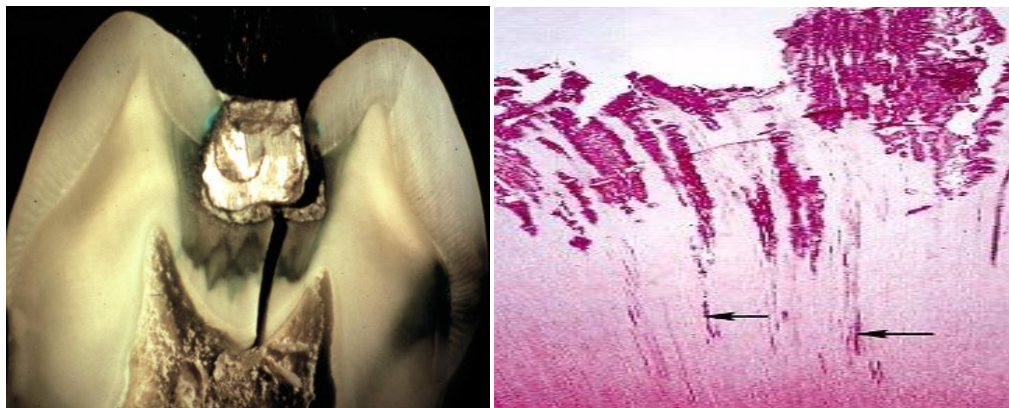
Professor Fusayama & colleagues at Tokyo Medical & Dental University realized that students needed scientific assistance to learn how to differentiate the **outer soft**

infected caries from the deeper harder affected dentine & normal dentine. A great deal of personal subjective variability exists between the touch of a hand-held probe from one clinician to another clinician—especially if the probe is sharp or dull. To provide a more scientific differentiation of diagnosis between outer (non-vital) infected caries & the underlying (vital) affected dentine, Dr. Fusayama & colleagues demonstrated that colored dyes selectively stain the **outer bacterially infected dentine** with a darker stain than the deeper **vital affected dentine**.

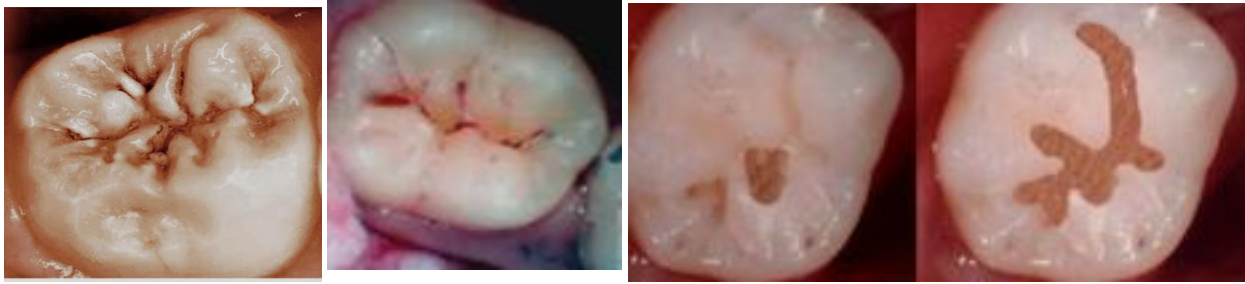
DO NOT REMOVE THE VITAL AFFECTED DENTINE: IT WILL REMINERALIZE

The first commercial caries detector was from Japan—based on the research of Professor Fusayama & his colleagues. Since then, other companies have developed caries dyes that range from **red, brown, green, blue** and **violet**.

To date, other diagnostic means, e.g. fluorescent dyes; densitometers; colorimeters; electrical resistance devices, ultrasound & lasers, which supposedly differentiates infected carious dentine from normal & affected dentine. However, these devices are more **expensive** than caries dyes & their diagnostic capacity remain problematic. Caries detectors are colored dyes that are mixed in a non-toxic Oligomer chemistry that simply stains the infected carious non-vital dentine & the bacteria that have penetrated into the dentinal tubule complex. Seen in the following figures

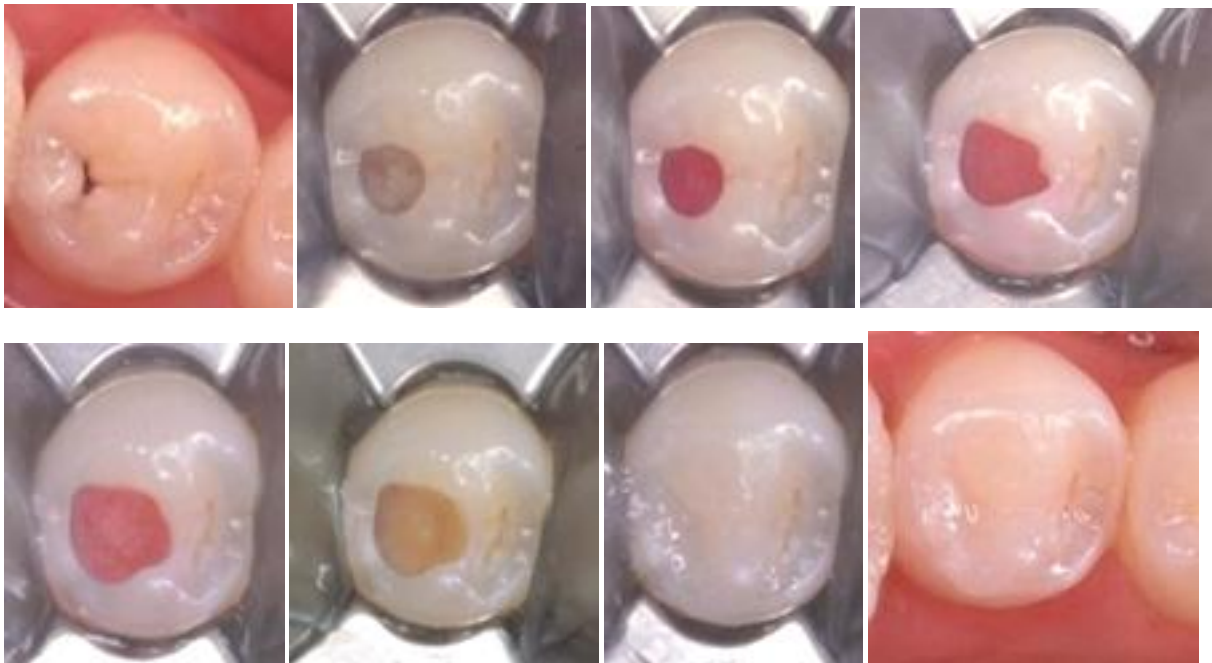


On the left—observe the recurrent caries below the Dycal[®] (CaOH)₂ base—under the amalgam. The right slide shows **DiscovRED** stained bacteria (arrows) in dentinal tubules that are from microleakage of proteolytic bacteria—allowing rapid bacterial growth that created a new zone of infected carious dentine & pulp inflammation.



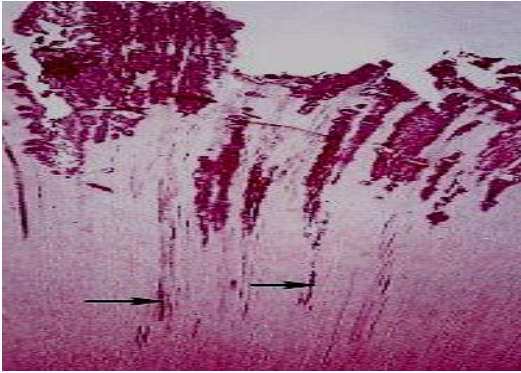
The two slides on the left show deep grooves with deep caries. Usual G.V. Black cavity preparations requires the **unnecessary removal** of great areas of normal dentine.

These two slides show Minimal Cavity preparation to permit very conservative adhesive restoration.



Dr. N. Akimoto, Tsurumi University, Japan

The above series show the clinical use of a caries dye. The top 2-right slides & lower left shows red stained infected caries. The following slide shows removal of infected caries & final restoration with an adhesive restoration. The use of a caries stain allows the dentist to prepare the cavity **without any needle anesthesia**. In addition, the stain permits removal--ONLY of the infected caries – leaving the remaining dentine in place for remineralization to re-strengthen the remaining tooth dentine.



DiscovsRED permits the identification of infected carious dentine & bacteria.