



WHAT IS FRANCISCAN?: REVISITED

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ACKNOWLEDGEMENTS

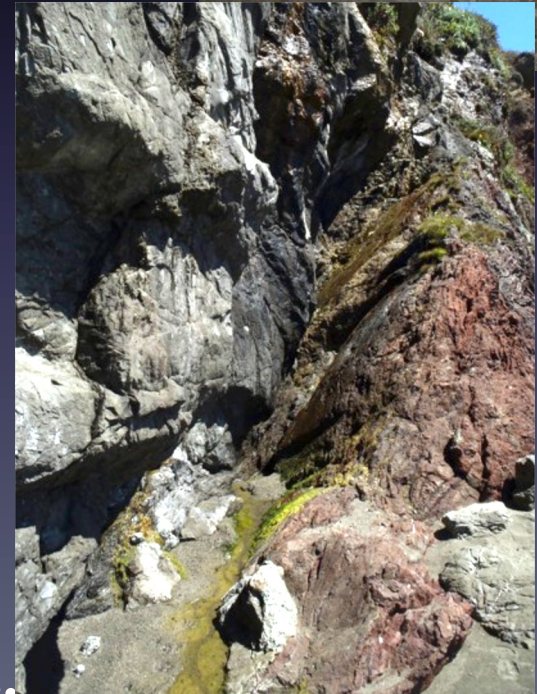
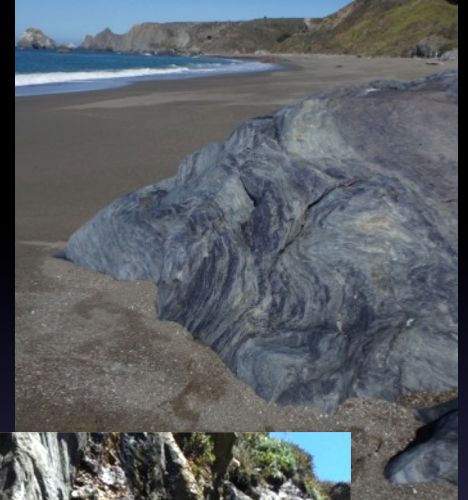
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STATE OF OUR KNOWLEDGE

The Franciscan Complex of California is much more thoroughly understood now than it was in 1964 when Bailey, Irwin, and Jones compiled their compendium on Franciscan rocks and in 1972, when Berkland et al. asked “What is Franciscan?” and defined the Franciscan as a Complex, dividing it into three belts.

The **DEFINITION** remains,

The Franciscan Complex is known as folded, faulted, and stratally disrupted rocks that together form the supramantle basement complex of the Northern and Central California Coast Ranges, and their extensions into southern Oregon, exposed east of the SA Fault and west of and structurally below the principal exposures of the Coast Range Fault, Coast Range Ophiolite, Great Valley Group, and Klamath rocks.



What has Changed from '72 to '16?

New data — especially **age data** of various types; data on **submarine fan facies**; **new large-scale maps**; and perspectives on fundamental **definitions** and *historical precedence* — suggest now that:

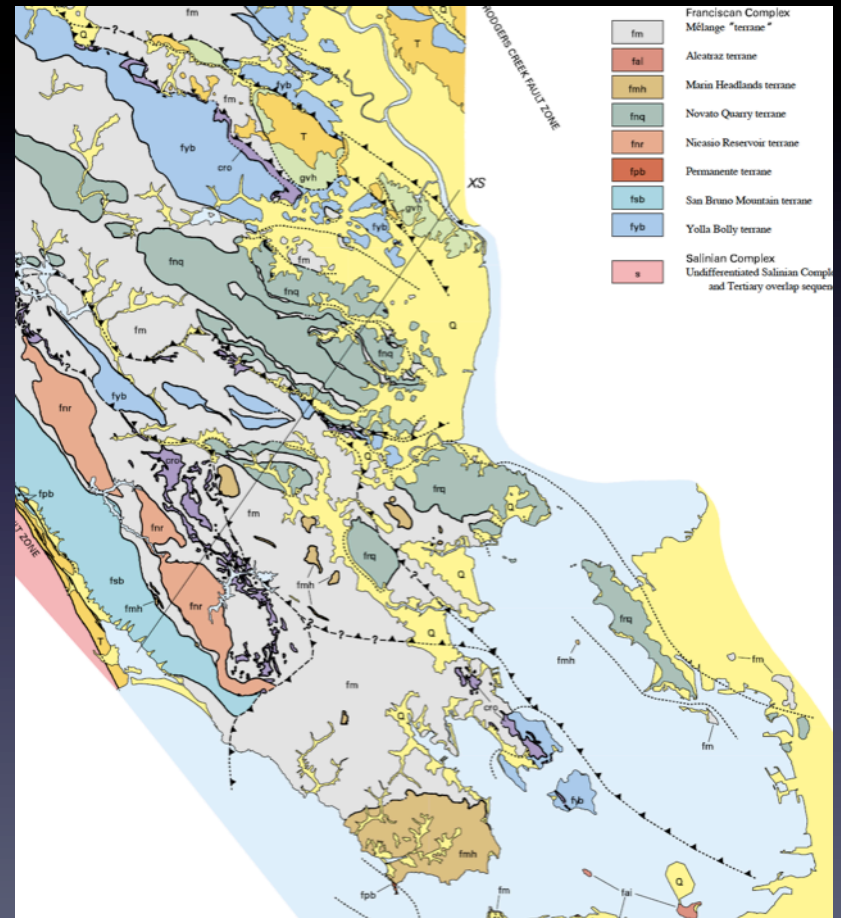
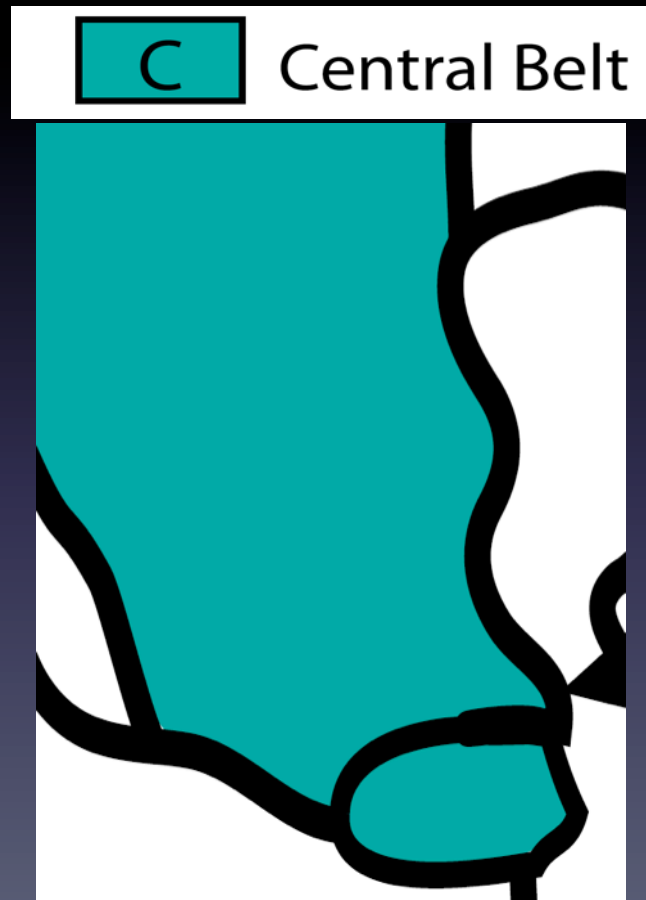
(1) the Belt terminology as applied to the entire Franciscan Complex is inconsistent with old definitions and current understandings of Franciscan architecture and character;

- (2) that **nappe** designations and most **terrane assignments** are inconsistent with existing definitions and our current understandings of Franciscan architecture and character, and should be abandoned; (3) that **underthrust-related accretionary masses (mélange bodies and underthrust sheets)** are the best **major architectural units** into which the **Franciscan Complex** should be divided; and
- (4) that lithostratigraphic and tectonostratigraphic units, such as broken formations and mélanges, mapped at the medium- to large-scale, are the best **local units** for subdivision of Franciscan architecture.

1 -BELT Names should be abandoned

Berkland et al. (1972) named the three belts that first served as major architectural units. These were later abandoned by some, subdivided into tectonostratigraphic terranes by others, yet continue to be used by still others.

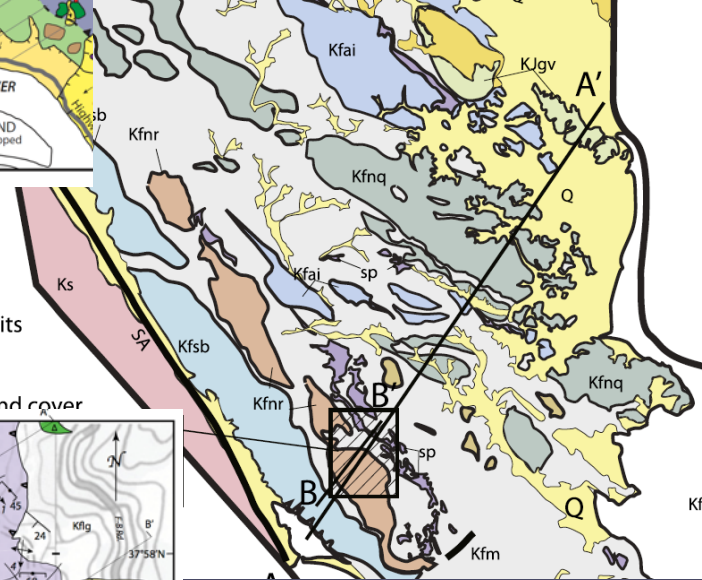
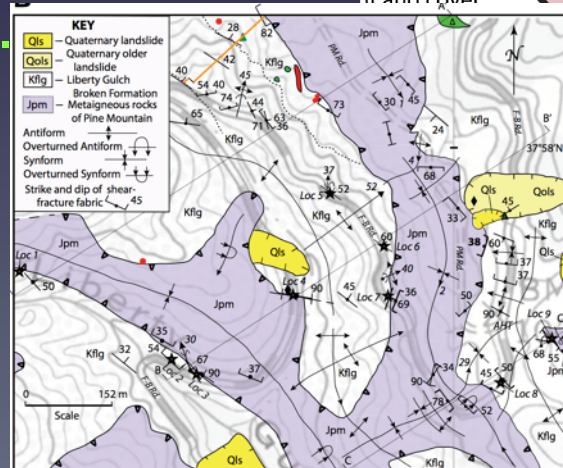
For example: Northern SF Bay Region — the old Central Belt has been subdivided into Marin Headlands Terrane, Novato Quarry Terrane, Angel Island Terrane, Nicasio Reservoir Terrane, Central Terrane, etc.



(From Blake et al., 2000)

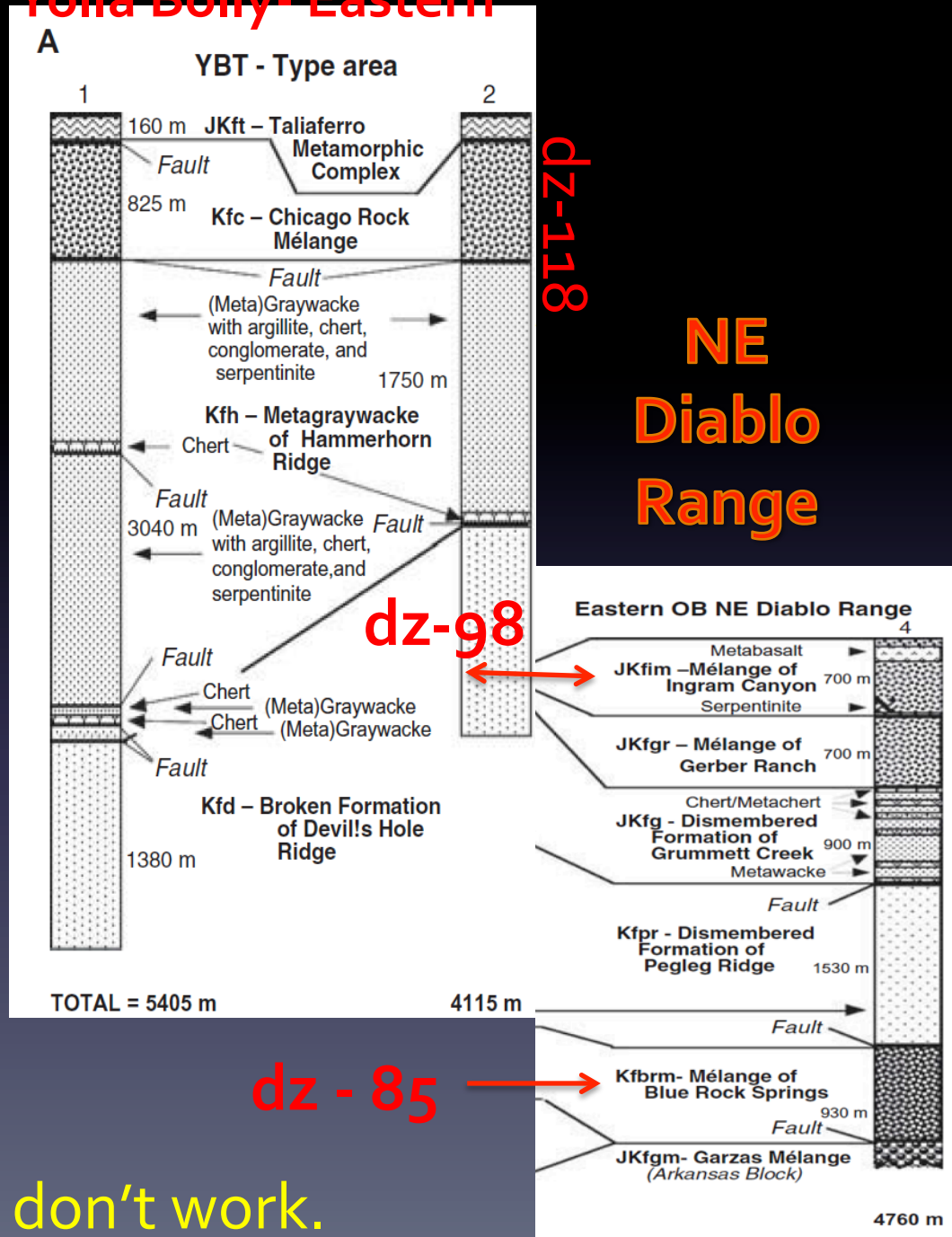
- The Central Belt north of San Francisco, thought to be dominated by shale-matrix melange, now is known to be dominated by Ss- rich units.

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- Geological map of Block 1 and Block 2, showing various geological units (Jbs, Jfsmm, Kfs, Qls, Qt, Or, U, Qls Ds, U/D, Cr) and their distribution. The map includes a scale bar (0 to 0.3 Km), a north arrow, and labels for the Pacific Ocean, Russian River, and Penny Island. A legend at the bottom indicates 'unmapped' areas.



Yolla Bolly - Eastern

In the NE Diablo Range, rocks thought to be Eastern Belt rocks b/c of mm grade & lithology, have DZ depositional ages generally younger than type-Eastern Belt (YB) rocks and they overlap the depositional ages of Central Belt rocks (Joesten et al. 2004; Raymond, 2014; Dumitru et al. 2015).



Belts as defined originally, don't work.

2 – Major Franciscan architectural units should not be called nappes.

Designating Franciscan architectural units as nappes is inconsistent with the definition and general use of the term “nappe;”

A **nappe** is defined as “a large allochthonous, sheet-like tectonic unit that has moved along a predominantly subhorizontal floor” (Dennis, 1967, International Tectonic Dictionary). The term now commonly connotes a **recumbantly folded (over)thrust sheet**. “**Nappe**” is not appropriate.

**3 - Most formerly named Franciscan terranes
do not fit the basic definition of a terrane,
hence, I argue that**

most (but not necessarily all) terrane names and designations
should be abandoned.

The Definition: Tectonostratigraphic terranes are defined as
fault-bounded regional blocks of rocks that have geologic
histories different from those of adjoining blocks (with which
no stratigraphic connection can exist) — defined on the basis
of geography, rock type, rock history, structures, and tectonic
history (Irwin 1972; Coney et al. 1980; Howell et al. 1985).

YET: Rocks in various terranes overlap in age and some are correlative. Notably, cherts are widely distributed in Eastern and Central (Belt) "terranes" and span the age range — Early Jurassic to Middle Cretaceous.



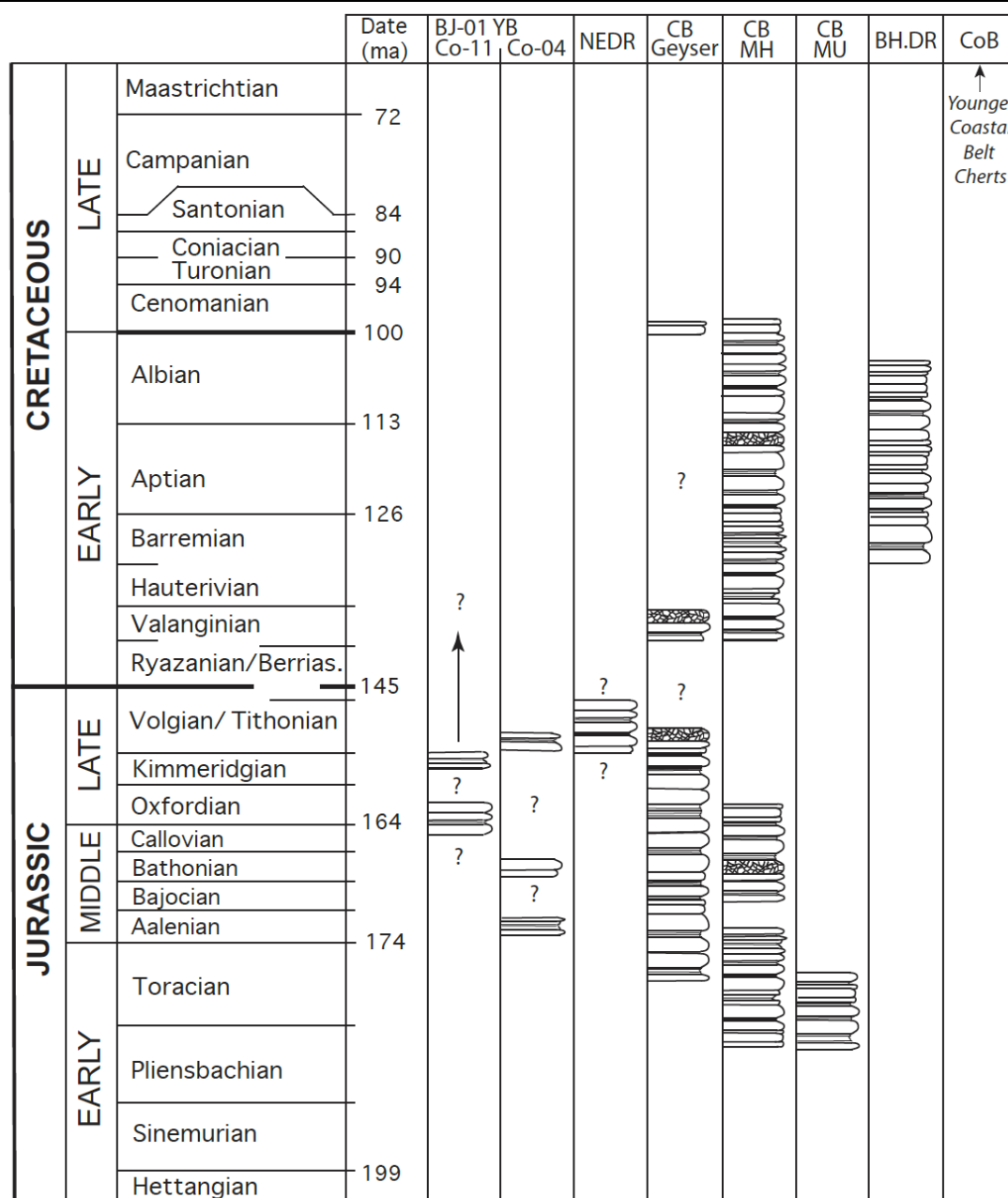
Marin Headlands
Terrane (Central Belt)



Heaven's
Beach
Melange
Central Belt



Eyer Mtn.
Terrane (?),
(Eastern Belt)
NE Diablo
Range



(Sources: McLaughlin & Pessagno, 1978; Murchey, 1984; Hagstrom & Murchey, 1993; Isozaki & Blake, 1994; Raymond, 2014; Dumitru et al., 2015)

Traditional
← Eastern Belt →

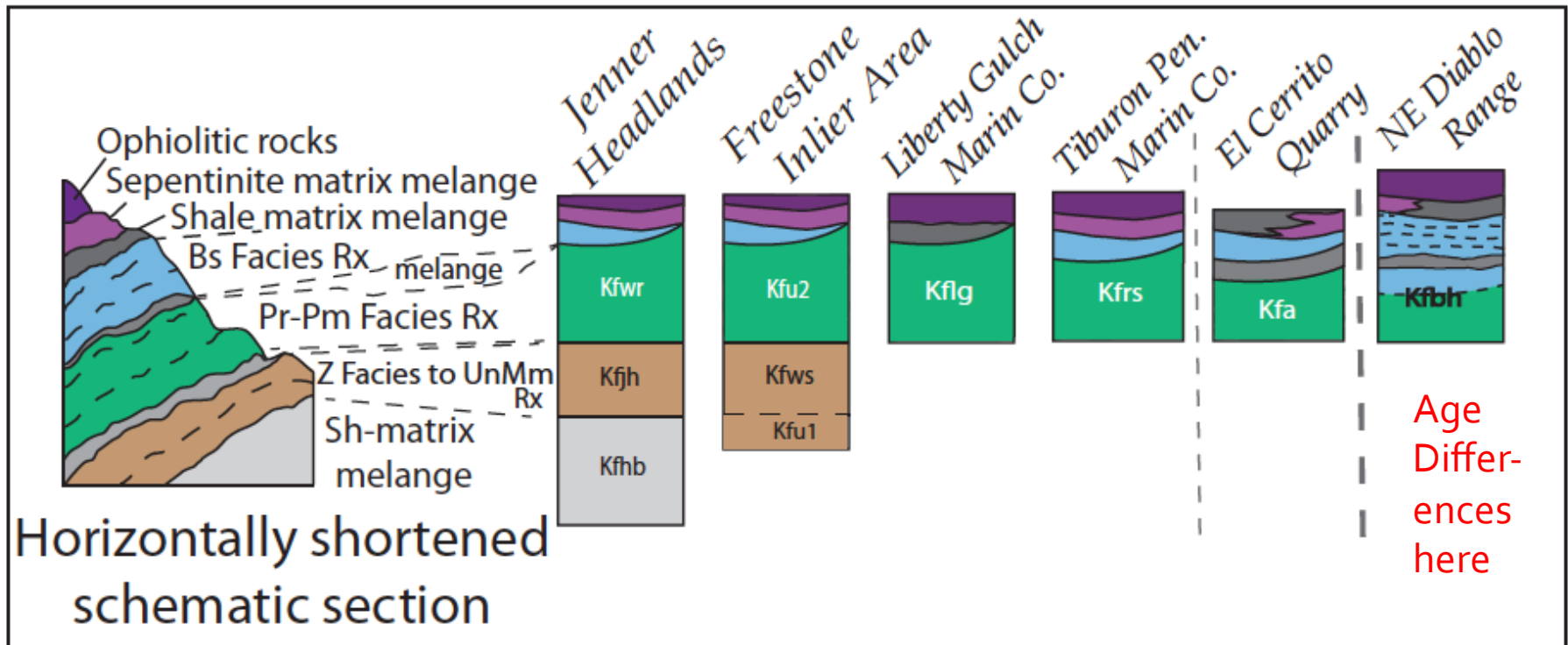
CENTRAL
← BELT →

Similarly, comparing the YB Terrane/Eastern Belt of far northern California with the Central Belt/Terrane there, the rock types are largely the same (*with a South Fork Mtn. exception*), with the major difference being that more mudrocks and high-grade blocks characterize parts of the Central Belt. Data presented and summarized by Dumitru et al. (2015) show significant overlap in age between the “Yolla Bolly Belt” /Eastern Belt and Central Belt rocks. Notwithstanding complexities not yet fully understood, these data suggest (1) that the belts are NOT entirely lithologically distinct and (2) that there are stratigraphic and provenance links between the two. Hence, by definition, the two are not separate tectonostratigraphic terranes.

4 — I suggest that

- Mappable **accretionary masses** are the best major architectural units into which the Franciscan Complex should be divided.
- What are **accretionary masses** ? They are **underthrust sheets** and **melange layers**.
- Scale — **10 - 100s of m thick and kms in lateral dimension**

- Wakabayashi (1990; 2015) previously suggested that correlative thrust sheets exist as major architectural units in the SF Bay area. Bero (2014), Raymond and Bero (2015), and Raymond (2016) likewise show repeated stacking of similar accretionary masses at various locales North of San Francisco. Accreted units include melange units marking megathrust zones (Wakabayashi and Rowe, 2015).



5 — Finally, ... I SUGGEST THAT

Medium- to large-scale lithostratigraphic and tectonostratigraphic units, such as formations, broken formations and mélanges, are the best local units for subdivision of Franciscan architecture and for illuminating detailed Franciscan sedimentological and structural history.

EXAMPLE

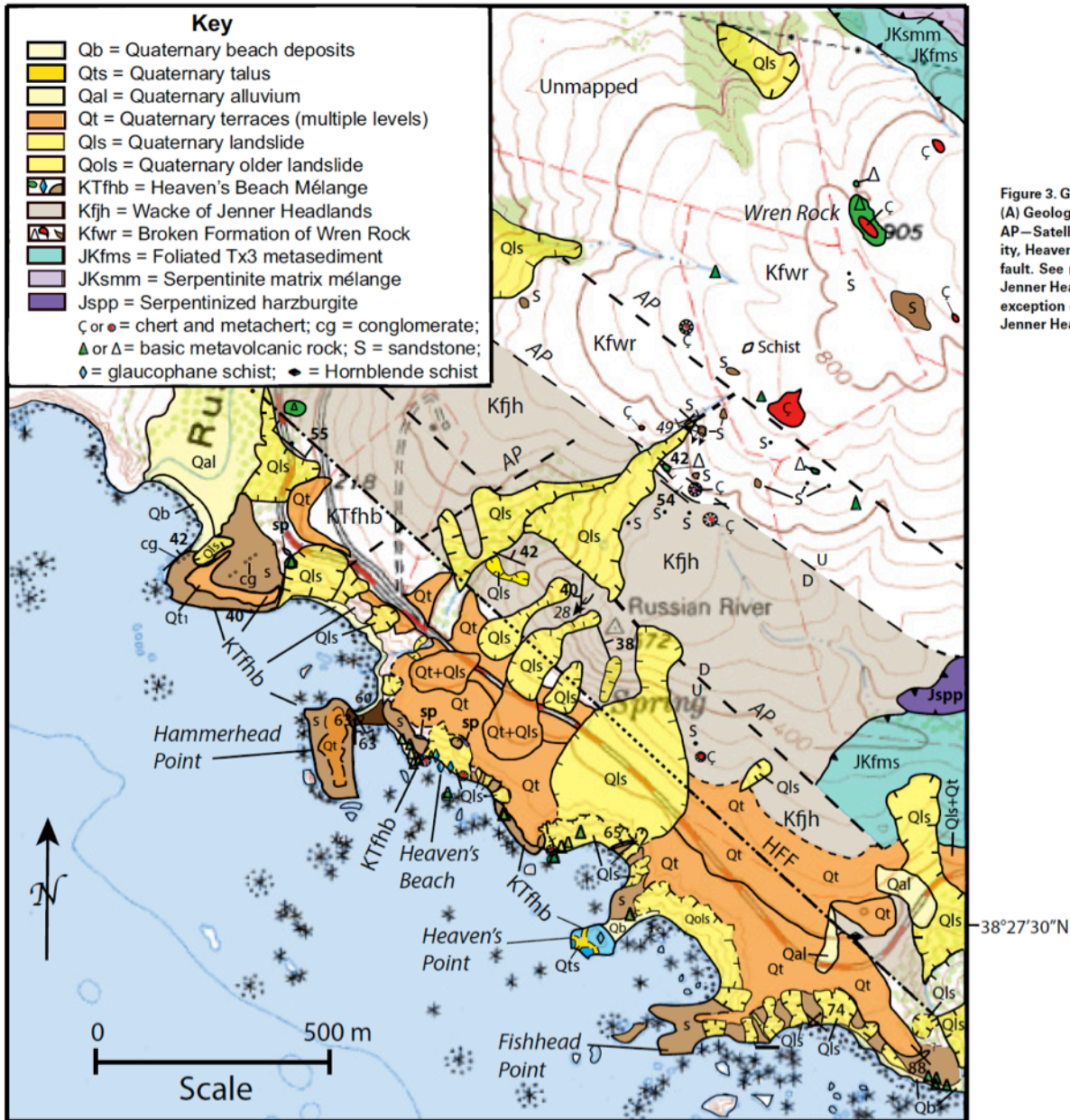
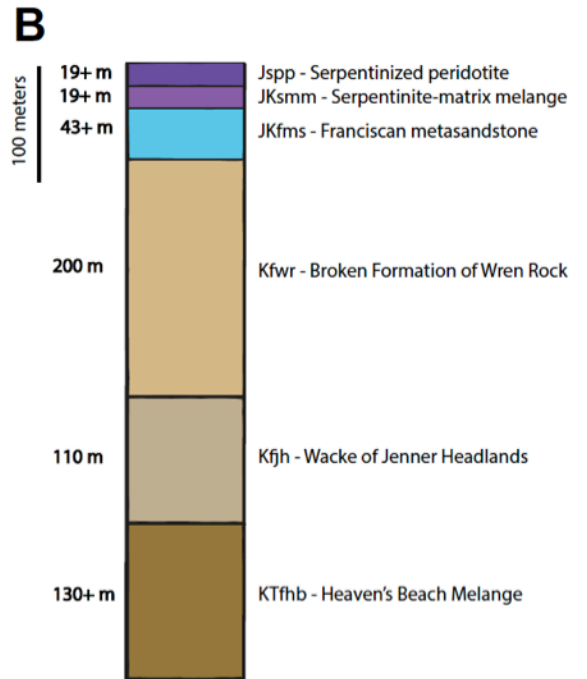


Figure 3. Geologic map and tectonostratigraphic column of the Russian Gulch–Hill 572/905 area. (A) Geologic map. Contacts along the eastern edge are based on reconnaissance by Bero (2010). AP—Satellite photo lineaments, some of which are recognized as small faults. The type locality, Heaven's Beach, of the Heaven's Beach mélange (KtHb) is labeled. HFF—Headlands Front fault. See map key for additional labels. (B) Tectonostratigraphic column of the northwestern Jenner Headlands area, showing unit thicknesses. All units are fault bounded, with the possible exception of a local depositional contact of Broken Formation of Wren Rock (Kfwr) on Wacke of Jenner Headlands (Kfjh).



Significant Controversies Remaining

Include:

- (1) The chert conundra (2 of them),
- (2) Megathrust vs. subduction channel issues, especially the nature and history of the former Central Belt,
- (3) The origins of many specific Franciscan mélanges
- (4) The nature of Franciscan Complex architecture, and
- (5) Resolution of the tectonic history (and best model) for uplift and widespread juxtaposition of relatively thin sheets of blueschist facies rocks and similar sheets of prehnite-pumpellyite facies rocks in the accretionary complex

(1) The Chert Conundra

First, do all chert bodies represent intermediate parts of sequential ocean crustal **basalt-chert-sandstone** sequences that require fault contacts between the chert and any underlying sandstone?

Corollary: Q.- Are any Franciscan cherts interbedded with sandstone?



The Chert Conundra

Second — if, all non-Coastal terrane Franciscan cherts formed in the equatorial Pacific between Early Jurassic and Middle Cretaceous time, does that not mean that any Franciscan unit containing those deposited cherts correlates, in part, with any other unit containing those cherts?

(2) Subduction Channels vs. Megathrusts.

Question: Which, if any,
Franciscan melanges
represent megathrust
faults? and which, if any,
represent subduction
channels?

(Solutions yield understanding
of the nature and history of the
former Central Belt)



OTHER NEEDED WORK

Other issues that need work (mostly of the ordinary science type vs paradigm shifting type) are: We need

- a detailed pre-San Andreas reconstruction of the North American margin for California (Franciscan-Great Valley Group focussed)
- additional detrital zircon dating to further clarify the complete sedimentation history of the Franciscan Complex
- delineation of major accretionary masses
- detailed maps of units within major accretionary masses



THANK YOU FOR YOUR
ATTENTION