The origin of the Cordilleran metamorphic core complexes is a matter of hot debate. Data in support of the evolving crustal shear-zone model are discussed. Joint work with G. A. Davis, S. J. Reynolds, and A. W. Snoke has resulted in evidence which suggests the existence of low-angle normal crustal movement zones, which evolve with increasing depth from low-angle normal 'detachment' faults, through zones of cataclasis, brecciation and/or seismic slip, into wide zones in which penetrative non-coaxial laminar flow takes place.

This model has been applied to the Southern Aegean, the Sea of Crete, and Crete. It is postulated that the Cycladic Archipelago contains metamorphic core complexes of Cordilleran type, which were drawn upward and outward from beneath the sedimentary basins now 100 km to the south, utilizing evolving crustal shear zones of the type discussed above. In the extending upper plate, extensive normal faulting took place, and subsidence was related to continental extension and the development of a sedimentary basin.

Analogous processes may have led to the rapid exhumation of the HP–LT metamorphic belt exposed in the external part of the Hellenides, in which case extensional tectonics has produced a distended paired metamorphic belt separated by an active sedimentary basin. By implication a novel hypothesis for the 'accretionary wedge' of the Hellenic arc can be made, in terms of crustal obduction, and migration of the flexure line of an unstable lithospheric slab. Gravitational spreading of the continental crust over a sinking lithospheric slab may be the mechanism driving the extensional process, although conditions imposed at the boundaries of the interacting 'microplates' must influence the situation.

Dislocation structures in naturally deformed sphalerite from Broken Hill, New South Wales.

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The dislocation structures observed by TEM in naturally deformed polycrystalline sphalerite (17 mole % FeS), from the Broken Hill ore-body, New South Wales, show a striking similarity to those developed in deformed face-centred cubic metals of intermediate to low stacking-fault energy. Material sampled from parts of the ore-body which have undergone different deformation histories display contrasting substructures and many specimens give evidence of multiple deformation over a wide range of physical conditions.

Coarse-grained macroscopically undeformed sphalerite, typical of much of the deposit, possesses both a regular subgrain (0.4–2 mm) and considerably finer cell (3–4 μm) structure. Weak-beam and HREM have established the dissociation state of dislocations in tectonically deformed sphalerite. Cell walls are composed of high densities of *LC* dislocations and sessile faulted dipoles. The configurations are analogous to those developed in tetrahedrally coordinated elements, but this is the first report of their occurrence in a compound semiconductor. Free dislocations within cells are not common but where observed, are seen to be heavily jogged, while some jogs are constricted, others are partially extended.

Dynamically recrystallized sphalerite occurring as a sulphide mylonite within the Globe–Vauxhall Shear Zone which transects the ore-body, exhibits no cell structure, but has a very high density of widely dissociated dislocations within fine sub-grains. Stacking faults extend across sub-grains and interactions such as the formation of faulted dipoles are absent. This is ample evidence that recrystallization has taken place by sub-grain rotation.

Sphalerite deformed at high temperatures and pressures in the laboratory develops an intensely faulted and twinned structure with little evidence of dynamic recovery in original or recrystallized grains. Strain-rate and chemical environment are probably major factors in the formation of these contrasting substructures.

Macro- to microfabrics of modern convergent margins.

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Convergent plate boundaries with high sediment supply construct relatively 'ductile' prisms of accreted sediment that show distributed deformation (e.g. Barbados, E. Aleutians, S. Mexico). Fold-and-thrust-belt structural style characterizes the initial deformation of overpressured sediments in ductile forearc regions. Seismic reflection profiles reveal long décollement surfaces with intervening thrust ramps. Thickness of initial thrust packages is directly proportional to the thickness of sediment on the incoming oceanic plate. Because of their weak consolidation, continuing deformation of ductile forearcs ultimately develops a complicated, stratally disrupted structural style characteristic of onland accretionary complexes. Ductile forearcs reveal high rates of tilting or kneading of the slope–apron deposits, with an exponentially decreasing rate landward of at least one trench (S. Mexico). Available estimates suggest less than 50% of total convergence is released near the seaward deformation front of ductile forearcs. For example, only about 5% of the total convergence is taken up near the seaward edge of the northern Barbados Ridge with decreasing strain arcward. Here, deformation is partitioned into distributed deformation (small-scale faulting and fabric development) and discrete faults that separate large-scale structural units within the accretionary prism. The discrete faults constitute potential terrane boundaries where substantial strike-slip may occur.

Convergent plate boundaries with low sediment supply develop forearcs underlain by both oceanic and island-arc ophiolitic basement complexes with deformation localized near the base of the trench slope (e.g. Marianas, Tonga, Guatemala). *DSDP* penetrations of these relatively 'rigid' forearcs reveal low rate of tilting of slope–apron deposits and locally conspicuous faulting. Analysis of faults from cores in the Mariana forearc reveals conspicuous strike-slip faulting supporting transform scenarios for tectonic erosion and terrane removal.

Small-scale structures of *DSDP* cores from active margins include strata disruption, scaly and spaced foliation, kink folds, pseudo-vein structure and microfaults. Stratal disruption is associated with cataclasis of sands, perhaps with overprinting solution effects. Cataclasis occurs in sediments 200–300 m below the sea floor. Cataclastic fabrics of the *DSDP* cores are precursors to web structure or cataclastic shear networks common in accretionary complexes on land. Scaly foliation is preferentially associated with reverse faults and shows anastomosing ultramicroscopic shear surfaces. Mesoscopic to microscopic kink folds are formed by mechanical crenulation of sedimentary layers during initial layer-parallel shortening in the proto-thrust zone of the Nankai Trough. Axial surfaces of the kink folds dip at about 60° and correlate with seismically resolved thrust faults. Spaced foliation involving the development of new phyllosilicate phases occurs in Late Miocene sediments that have never been buried more than 300 m. Micro- and ultramicroscopic studies of pseudoveins show no evidence of hydrofracturing but rather suggest slow fluid expulsion following disaggregation by grain-boundary sliding and displacement in an extensional upper-slope environment.

Deformation in the contact aureole of the Wyangala Batholith, New South Wales.

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The Siluro-Devonian Wyangala Batholith has intruded slates, phyllites, metagreywackes, quartzites and metacherts of Late Ordovician age and greenschist-facies metamorphic grade. Before granite intrusion these rocks were deformed into tight to isoclinal folds with a slaty cleavage, S_1. Adjacent to the granite they were recrystallized to varying degrees into hornfelsic rocks with cordierite + biotite and cordierite + andalusite-bearing assemblages. Contact metamorphism obliterated much of the S_1 fabric in the contact aureole producing isotropic fabrics in many rocks, with randomly oriented porphyroblasts of cordierite, muscovite and andalusite being common. A second deformation subsequent to intrusion formed a cleavage, S_2, in the country rocks and a foliation in most of the granitic rocks. The contact aureole also underwent deformation accompanied by retrogression of cordierite and much of the andalusite under greenschist-facies conditions. This has resulted in a variety of fabrics including schistose, slaty and hornfelsic textures. Whereas S_2 in pelites outside the contact zone is a crenulation cleavage, within the aureole S_2 is commonly a slaty cleavage. The role of pressure solution in producing S_2 appears to be much more important outside the contact aureole than within it. Deformed retrogressed cordierite porphyroblasts in contact metamorphosed black slates have been used to estimate strain ellipsoids for the second deformation. These ellipsoids are mostly of oblate shape with the long axis (X) parallel to the local B^2 fold axes or lineations. Boudinaged andalusite porphyroblasts in black slates are evidence of extension along the X direction.