STRATIGRAPHY ALONG THE NORTH FLANK OF FRENCHMAN CAP DOME, SOUTH OMINECA BELT, BRITISH COLUMBIA (82M/10, 15)

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INTRODUCTION

An understanding of the stratigraphy in the south-central part of the Omenica Belt has played a major role in deciphering the structure and tectonic evolution in the region (Simony *et al.*, 1980; Raeside and Simony, 1983; Brown *et al.*, 1986; Brown and Lane, 1988). Several stratigraphic packages of the North American continental terrace prism have been traced from zones of low metamorphic grade into the high-grade core zone of the Columbian orogen (Pell and Simony, 1987) which straddles the suture zone between autochthonous North American rocks and accreted terranes. Within this zone, metamorphism, crustal anatexis (Raeside, 1982; Sevigny *et al.*, in press) and intense deformation obscure the original character of the sedimentary rocks.

The field area lies within the north-central part of the Shuswap metamorphic complex in the southern Omenica Belt (inset Figure 1-7-1). These little-studied rocks have been mapped on a reconnaissance scale by Wheeler (1965), and in local detail in the vicinity of the Ruddock Creek lead-zinc deposit by Fyles (1970). This area physically links defined stratigraphy and structures in the Selkirk allochthon west of Mica Dam and in the Selkirk Mountains, to the Monashee Complex (Read and Brown, 1981). Therefore, knowledge of its rocks will provide an improved basis for stratigraphic, structural and tectonic interpretation and will aid mineral exploration and resource evaluation in the region.

Work during the 1988 field season included 17 days of sampling and detailed mapping (1:20 000) of approximately 80 square kilometres of alpine exposures best accessed by helicopter from Revelstoke. Continued research will include uranium-lead dating, lead isotope studies, $^{40}Ar/^{39}Ar$ isotopic analysis, the application of various geothermometers and geobarometers, and further detailed mapping. This contribution deals with the stratigraphy of the area.

REGIONAL TECTONIC SETTING

Major tectonic elements identified in the southern part of the Omenica Belt include, in ascending structural order: the Monashee Complex, Monashee décollement, Selkirk allochthon, Quesnel Lake fault and Quesnel Lake thrust sheet. These elements are interpreted to be part of a large-scale system of overthrusting along low-angle westerly rooting shear zones (Brown *et al.*, 1986). The Monashee Complex, one of several metamorphic core complexes (Crittenden *et al.*, 1980) within the southern Omenica Belt, is exposed through a tectonic window in the Selkirk allochthon and Monashee décollement. It is cored by early Proterozoic paragneisses and granitic orthogneisses, unconformably overlain by mantling gneisses composed dominantly of metamorphosed platformal sedimentary rocks. Protoliths of the latter are inferred to be at least late Proterozoic to early Cambrian in age (Höy and Godwin, in press; Parrish and Scammell; in press). The Monashee Complex constitutes a suspect terrane, and has been interpreted as compressed, initially attenuated North American continental crust and early platform sediments (Brown *et al.*, 1986; para-autochthonous terrane of Monger *et al.*, 1985). Rocks of the complex are polydeformed and record two distinct synkinematic metamorphic episodes (Journeay, 1986; Scammell, 1986). Reworked basement rocks also make up the Malton gneiss to the north.

The Monashee décollement is a fundamental regional tectonic boundary. It is a mylonitic shear zone, which records easterly directed motion of its upper plate (Brown and Murphy, 1982; Lane, 1984; Journeay, 1986; Scammell, 1986; Bosdachin and Harrap, 1988). It forms the upper boundary of the Monashee Complex, and truncates structures, isograds and lithostratigraphic units in both plates. Recent work by Journeay (1986) and Scammell (1986) suggests that it records early high-pressure and later low-pressure displacements.

The Selkirk allochthon is a composite tectonic sheet in the hangingwall of the Monashee décollement (Read and Brown, 1981). It is composed of rocks ranging in age from Proterozoic to Middle Jurassic. Stratigraphic divisions of Late Proterozoic Horsethief Creek Group rocks, considered correlative with the Windermere Supergroup, have been traced north from the Purcell Mountains, through the Selkirk and Monashee mountains (some 15 kilometres north of the field area) to the Cariboo Mountains (*see* Pell and Simony, 1987). Major southwest-verging nappes that predate Middle Jurassic regional metamorphism and east and west-verging second-phase folding have been documented (Cairns nappe, Brown and Lane, 1988; Scrip nappe, Raeside and Simony, 1983). These structures control the megascopic distribution of rock units in the allochthon. High-pressure Barrovian-type assemblage zones and crustal anatexis characterize rocks of the Selkirk allochthon in the vicinity of the map area.

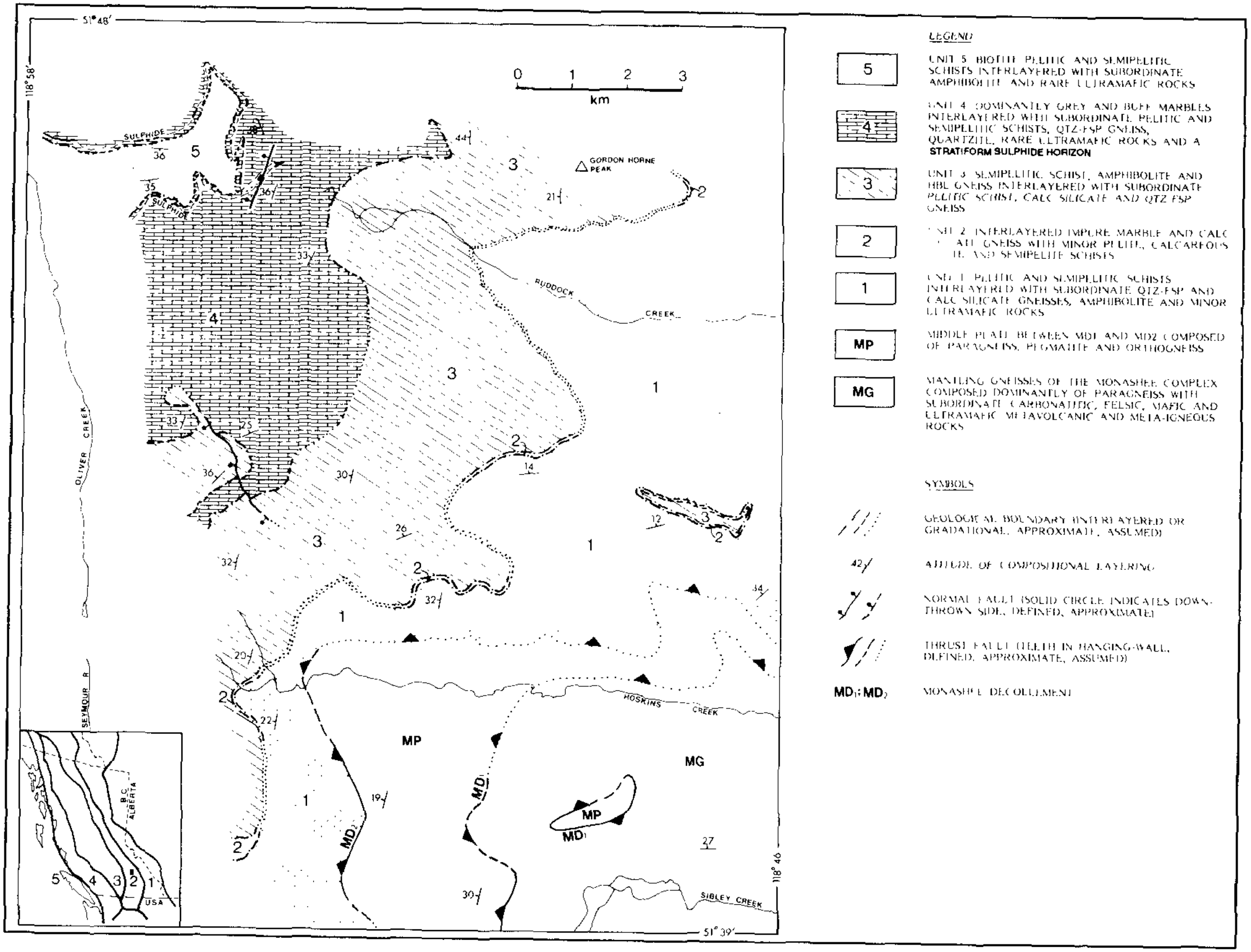

Figure 1-7-1. Stratigraphic map of the north flank of Frenchman Cap dome. Data compiled from Fyles (1970), Wheeler (1965), Journeay (unpublished data, 1987), Scammell (unpublished data, 1988) and Scammell (1986). Note that the numbers of units imply structural order. Inset map of British Columbia displays five morpho-tectonic belts of the Canadian Cordillera: (1) Foreland Fold and Thrust Belt, (2) Omenica Belt, (3) Intermontane Belt, (4) Coast Belt, and (5) Insular Belt. The approximate location of the field area is shown as a black rectangle in the Omenica Belt.

The Quesnel Lake fault is a mylonitic east-directed overthrust (Rees and Ferri, 1983). Rocks in its hangingwall comprise ophiolitic rocks of the eastern terrane and late Paleozoic to early Jurassic island-arc rocks of the Quesnellia terrane.

LITHOLOGY

The map area is underlain by a stratified sequence composed of a wide range of metamorphic rock types including pelitic, quartzofeldspathic, siliceous, calcareous, calc-silicate, mafic and ultramafic varieties. These individual rock types show little variation throughout the sequence, and are described in a general manner.

Pelites are layered on a scale of tens of centimetres to metres. They are generally discontinuous, but some can be traced for several hundred metres. Discontinuous and continuous finer laminations are defined by changes in grain size and/or modal proportions of constituent minerals. Pelites are commonly extensively weathered with heavy iron oxide staining. Grain size generally ranges from 2 to 10 millimetres with garnet porphyroblasts reaching diameters of 5 centimetres. They are composed of quartz, feldspar, biotite, muscovite, chlorite, garnet and fibrous sillimanite intergrown with biotite. Pelitic rocks comprise greater than 50 per cent phyllosilicates, and 5 to 50 per cent quartz and feldspar. Lithochemical variation and changes in metamorphic grade have resulted in some pelitic schists which do not contain one or a combination of garnet, sillimanite or muscovite. Individual layers exhibit both sharp and gradational margins. While gross layering is a product of primary deposition of aluminous sediments, fine layers are products of both primary sedimentation and dynamothermal processes.

Pelites are commonly interlayered with semipelitic schist (less than 50 per cent mica), quartzofeldspathic gneiss and siliceous rocks, on a scale of centimetres to metres. Semipelitic rocks have a higher proportion of quartz and feldspar, and less sillimanite, but otherwise are similar in most aspects to pelitic rocks. Layers of quartzofeldspathic gneiss consist of abundant coarse-grained (greater than 2 millimetres) feldspar and quartz with accessory minerals including mica, amphibole, pyroxene and garnet. Variation in the proportion of quartz, feldspar and accessory minerals defines millimetre-scale discontinuous laminations. These gneisses are believed to be metamorphosed greywackes and feldspathic sandstones. Siliceous rocks are rare. Coarse-grained quartzites occur as discontinuous layers 10 centimetres to 2 metres thick. Concentrations of accessory minerals including garnet, hornblende, diopside, muscovite and biotite define millimetre-scale laminations. These quartzites represent metamorphosed quartz arenites.

Calcareous rocks are the best marker horizons in the map area. Most common are impure marbles layered on a centimetre to metre scale and outlined by alternating resistant and recessive grey and buff layers. Fresh surfaces are buff, light grey and rarely white, and give off a fetid odour. Although they are dominantly composed of coarse-grained calcite and minor dolomite, highly strained varieties may be fine grained. The concentration of accessory phases including quartz, diopside, plagioclase, garnet, graphite and epidote defines faint centimetre-scale laminations with gradational boundaries. These calcareous rocks are most commonly interlayered with calc-silicate gneisses (less than 50 per cent calcite) which comprise gross metre-scale units more finely layered on a millimetre to centimetre scale with alternating carbonate and silicate-rich layers. These rocks typically contain coarse-grained calcite, quartz, plagioclase, epidote, phlogopite, garnet, diopside, sphene, hornblende and rare sulphides. Together with calcareous rocks they represent interlayered pure limestones, dolostones, shaly or quartz-bearing limestones and dolostones.

Grey to black-weathering coarse-grained mafic rocks are present throughout the sequence. Hornblende-rich (greater than 70 per cent) amphibolites commonly form centimetre to metre-scale layer-parallel boudins around which metasedimentary rocks have been deformed. Original contact relationships have generally been obscured by strain. Accessory phases, which are not always present, include garnet, biotite and diopside. Hornblende-rich varieties generally do not display fine laminations. Some amphibolites are so deficient in plagioclase that they constitute hornblendites. Others exhibit fine layering defined by discontinuous alternating plagioclase and hornblende-rich layers. These latter amphibolites exhibit both sharp and gradational contacts with surrounding metasedimentary rocks. Although some of the mafic rocks may represent metamorphosed siliceous shaly dolomites, most are believed to represent an array of basaltic or gabbroic sills and transposed dykes, flows, tuffs and reworked volcaniclastic material. Sevigny (1987) has made this interpretation to the north.

Rare ultramafic rocks are exposed sporadically within the succession as massive metre-scale boudins. They exhibit a wide variety of textures. Fine-grained ultramafic rocks are weakly foliated, and weather greenish grey, locally with up to 10 per cent weakly rusty spots (olivine?) 5 to 10 millimetres across. Thin-section examination is required to identify their mineralogy. Coarse-grained varieties display spectacular radiating laths of ortho-amphibole 1 to 5 centimetres long, and other presently unidentified apple-green to brown lath-shaped minerals set in a matrix of talc, serpentine, phlogopite and iron oxides. These rocks represent metamorphosed peridotites, dunites and possibly pyroxenites.

STRATIGRAPHY

High-strain, sillimanite-grade metamorphism, migmatization and granitic intrusion have obliterated all primary structures apart from gross compositional layering. A regional stratigraphy has been delineated on the basis of typical associations and facies relationships, the local preponderance of certain rock types, and the presence of rare laterally persistent marker horizons. Five composite lithostratigraphic units have been mapped (Figure 1-7-1). Contacts are most commonly interlayered and less commonly gradational or sharp. No obvious breaks or unconformities were observed in the stratigraphic sequence, and it is therefore presently considered to be one coherent succession.

Attenuation of the sequence is evidenced by the discontinuous nature of most lithologic units, boudinage of more competent layers, mylonitic fabrics and a penetrative west-trending mineral-stretching lineation. Three phases of folding have been recognized. The first two, found throughout the map area, are metre to kilometre scale and generally thin the section along their limbs. Their higher-order structures thin and thicken sections locally. Third-phase folds are locally developed and have relatively little effect on section thickness.

Apparent passive intrusion of subconcordant granitic bodies has not generally disrupted the orientation of the metamorphic foliation in the host rocks. These granitic rocks may comprise more than 50 per cent of the rock type at the megascopic scale. Consequently, original stratigraphic thicknesses are not known. Megascopic thicknesses quoted include intrusive granites and deformation effects, and are therefore only first approximations. Medium-grained granites, pegmatites and other leucosomes are present throughout the succession and are not considered to be part of the original stratigraphic succession but rather a metamorphic effect superimposed on the original sequence and are consequently not described. The succession is described in ascending structural order from the uppermost splay in the Monashee décollement (Journeay, 1986; Journeay and Brown, 1986).

UNIT 1

This unit lies in fault contact with the Monashee décollement (Journeay and Brown, 1986; Journeay, unpublished data, 1987). It is approximately 600 to 2000 metres thick, and comprises an interlayered succession dominated by pelitic and semipelitic schists with minor quartzofeldspathic gneiss, amphibolite, calc-silicate and ultramafic rocks. Journeay (unpublished data, 1987) has recognized one discontinuous composite subunit composed dominantly of interlayered calc-silicate gneiss and amphibolite which hosts sporadic boudins of brown-weathering ultramafic rocks. This subunit is 0 to 500 metres thick, and lies in the central part of Unit 1.

UNIT 2

This calcareous unit constitutes one of the few reliable marker horizons, and can be traced for more than 10 kilometres. It is composed of interlayered centimetre-thick impure marbles and calc-silicate gneiss wtih minor pelite, calcareous pelite and semipelite schists. Although locally discontinuous, it may reach more than 10 metres in thickness. It is interlayered with bounding units.

UNIT 3

This unit, approximately 1500 to 2300 metres thick, is composed dominantly of semipelitic schists, amphibolite and hornblende gneiss interlayered with subordinate pelitic schists, calc-silicate and quartzofeldspathic gneisses. These rocks are interlayered on a scale of centimetres to metres. Although generally discontinuous on a 10-metre scale, some subunits dominated by amphibolites and rusty pelitic schists can be traced for several kilometres. Thin interlayered marble and calc-silicate horizons appear towards the top of the unit. Unit 3 is capped by a sillimanite-rich rusty horizon of pelitic schists 5 to 30 metres thick.

UNIT 4

Rusty pelitic schists of Unit 3 are overlain along an interlayered contact by a succession of dominantly thick grey and buff marbles interlayered with subordinate rusty pelitic schists, semipelitic schists, quartzofeldspathic gneiss, quartzite and ultramafic boudins. This calcareous succession forms a distinctive horizon from east of the headwaters of Oliver Creek to west of Gordon Horne Peak. It ranges from 900 to 1000 metres thick. Individual metre-scale marble horizons can be traced along strike for several kilometres. Although at least five of these horizons have been mapped, some may represent repetitions due to folding. The Ruddock Creek lead-zinc sulphide horizon (Wheeler, 1965; Fyles, 1970) appears to be one of the structurally highest subunits of Unit 4. This 2 to 5-metre-thick discontinuous stratiform sulphide-bearing member outlines a type-3 fold interference pattern. It comprises two sulphide layers 0.5 to 5 metres thick, composed of sphalerite, pyrrhotite, galena, pyrite and chalcopyrite, interlayered with calc-silicate gneisses, impure marbles, semipelitic and pelitic schists, and rare lenses of fluorite and barite (Fyles, 1970). Layer-parallel lenticular pods and boudins of ultramafic rocks are found above and below the sulphide-bearing subunit. Discontinuous metre-scale marble horizons mark the top of Unit 4.

UNIT 5

This unit cores the synformal structure outlined by the sulphide-bearing subunit in Unit 4. It is at least 300 metres thick and dominated by pelitic and semipelitic biotite schists interlayered with minor amphibolite and rare ultramafic lenses.

DISCUSSION

Rocks in the map area comprise part of Wheeler's (1965) map unit E which extends south from west of the Big Bend in the Columbia River to west of the Monashee Complex with no known structural breaks. Brown (1980) has suggested that these rocks are correlative with the late Proterozoic Horsethief Creek Group present in the Selkirk allochthon. Comparison of the sequence of rocks in the map area with published descriptions of Horsethief Creek rocks (Simony *et al.*, 1980; Raeside and Simony, 1983; Pell and Simony, 1987) reveals strong similarities and suggests specific correlations with rocks of the Horsethief Creek Group.

North of the study area Horsethief Creek rocks comprise a succession of pelitic and semipelitic schists, amphibolites, marbles, calc-silicate and quartzofeldspathic gneisses 4 to 5 kilometres thick. These rock types are typical of the study area. Raeside and Simony (1983) describe five subdivisions which include, in ascending stratigraphic order: lower pelite, lower marble, semipelite-amphibolite, main marble (middle marble), and upper clastic divisions. They describe the lower marble subdivision as an asymmetric sequence with amphibolite at its base, overlain by rusty pelite capped by interlayered marble and calc-silicate. Rocks in the upper part of Units 1 and 2 show a similar asymmetry comprising a subunit dominated by amphibolite and calc-silicate rocks overlain by interlayered semipelite and pelitic schists capped by calcareous rocks of Unit 2. Semipelitic and pelitic schists and minor amphibolite in the lower part of Unit 1 comprise a sequence similar to rocks in the lower pelite division. The semipelite-amphibolite subdivision is characterized by massive semipelites with interlayered pelites and thin amphibolites; a succession similar to Unit 3 of the study area. Overlying rocks in both areas (Unit 4 and the main marble or middle marble) comprise sequences dominated by marbles interlayered with pelitic and semipelitic schists. This calcareous sequence is much thicker in the field area than to the north. The present database on this structurally complex part of the section does not allow determination of the original stratigraphic thickness, or confident positioning of the lead-zinc horizon and Unit 5 in a stratigraphic sequence. Lead-zinc-bearing sequences similar to the Ruddock Creek deposit are not described elsewhere in Horsethief Creek stratigraphy but Unit 5 is similar to semipelite, pelite and psammitic rocks interlayered with minor amphibolites at the base of the upper clastic division.

Simony *et al.* (1980), Raeside and Simony (1983), and Sevigny and Simony (in press) have mapped a southwest-verging nappe (Scrip nappe) in the Horsethief Creek Group, with an overturned limb in excess of 50 kilometres long. An underlying syncline links the nappe to upright Horsethief Creek stratigraphy in the vicinity of the Malton gneiss. The nature of these structures implies that the underlying syncline and upright stratigraphy should extend to the south.

The above discussion outlines the similarity between the stratigraphic succession established to the north and the structural succession in the field area. In the region which links these two areas Wheeler (1965) has mapped marble horizons that are most likely correlative with Units 2 and 4 of the study area. It is therefore proposed that rocks in the map area generally comprise (with the possible exception of the Roddick Creek horizon and Unit 5) part of a succession of Horsethief Creek stratigraphy in the upright limb of the syncline which underlies the Scrip nappe. Assessment of this proposal requires more detailed data from the region to the north of the field area.

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