LATE PALAEOZOIC LARGE IGNEOUS PROVINCES, OROGENY AND METALS - precious and base metals from the sub-continental mantle

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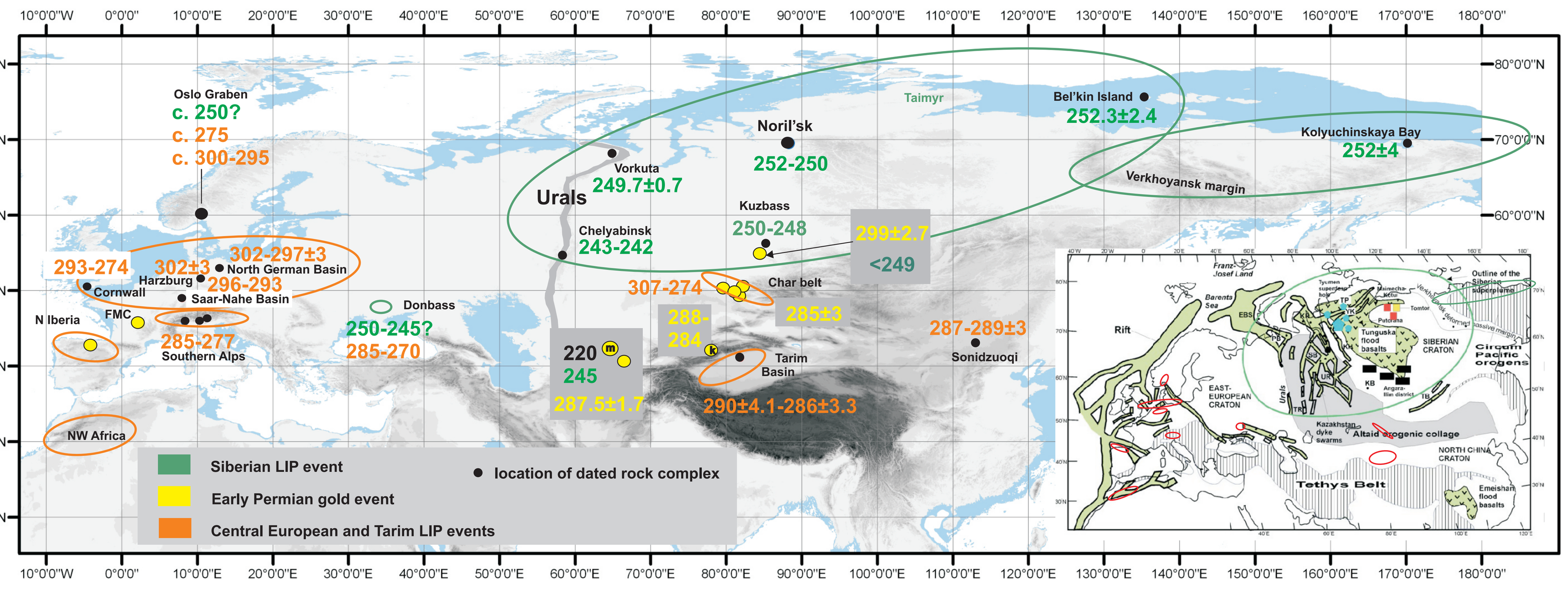
Key words: large igneous province, orogeny, trans-lithospheric, strike-slip, gold, pge, base metals

Three Late Palaeozoic, continental, large igneous provinces (LIPS) were each formed on termination of orogeny:

“Were the contemporary ore deposits associated with the preceding orogeny or with the LIP-forming processes in the sub-continental mantle?”

Figure 1 LATE PALAEOZOIC LARGE IGNEOUS PROVINCES AND CONTEMPORARY ORE DEPOSITS IN EURASIA (modified after Nikishin et al., 2002)



TEMPORAL RELATION OF LIPS WITH OROGENY

The Early Permian Central European LIP trailed the Variscan Orogeny in Europe,
The Early Permian Tarim LIP trailed the South Tianshan Orogeny in Central Asia,
The Permo-Triassic Siberian LIP trailed the Western Altaid Orogeny in Western Siberia.

ORE DEPOSITS

The most prominent contemporary ores include gold- and tin-tungsten deposits in the theatres of Europe and Central Asia, historically seen in relation with the orogens.
Nickel-copper(-PGE) deposits as in Western Siberia, are considered an aspect of processes in mantle (metals) and crust (sulfur).

METAL ASSEMBLAGES

The metal tags are dictated by economic interest.
They obscure the arsenic, antimony, tungsten, bismuth, tellurium and mercury in the gold deposits, which occur also in the tungsten-tin deposits as well as in the nickel-copper deposits.
The economic tags also obscure the occurrence of nickel and copper in gold deposits.
All of these elements are found in most deposits, albeit in different proportions.

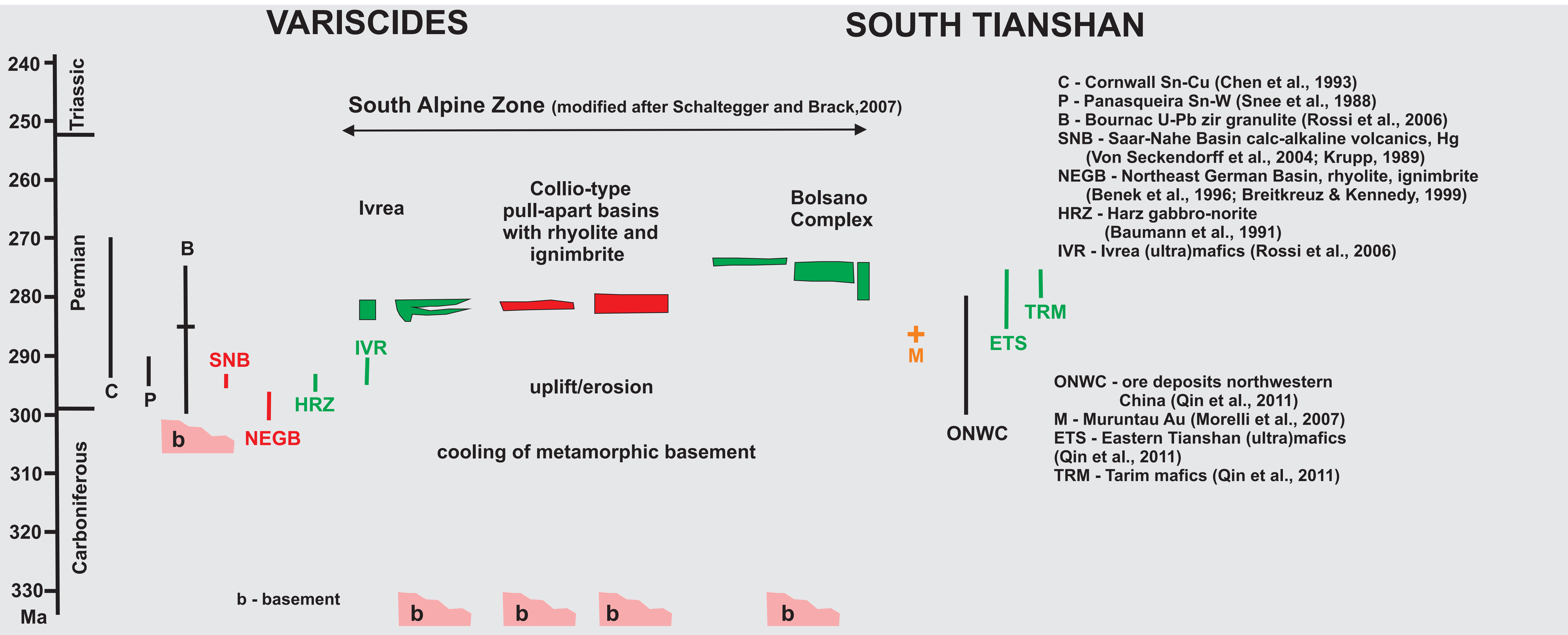
IN VIEW OF ITS RECURRENCE, THE OROGEN-LIP SEQUENCE IS PROBABLY NOT FORTUITOUS.
“WHAT DOES THIS MEAN FOR METALLOGENY AND WHAT IS THE CONNECTING ELEMENT?”

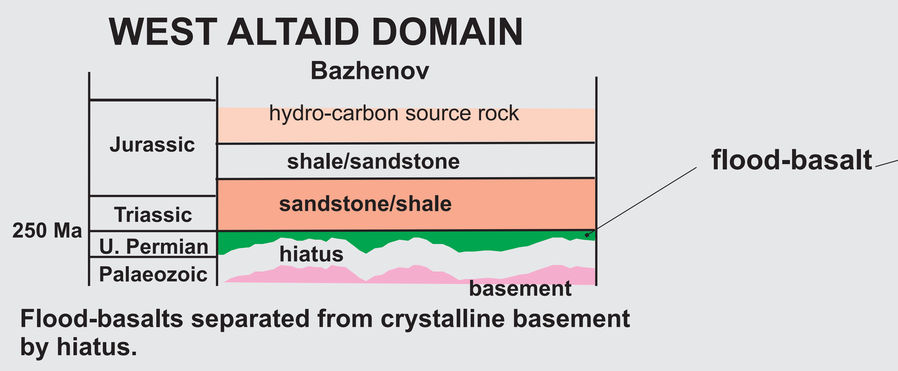
Figure 2 TEMPORAL DISTRIBUTION OF LIPS RELATIVE TO END OF OROGENY

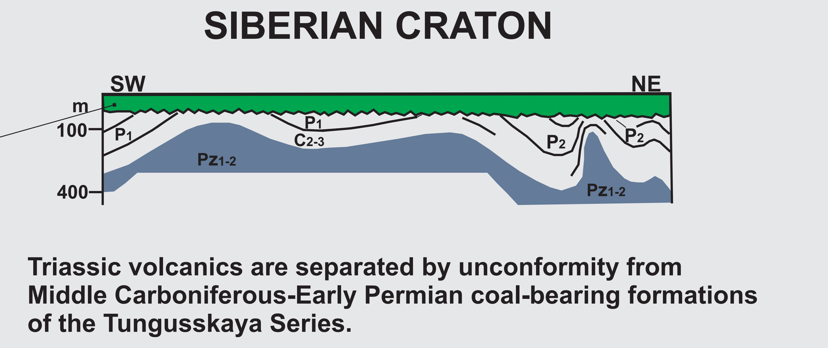
Figure 2A - Stratigraphic elements in the South Alpine Zone compared with miscellaneous elements in the Variscan Domain (left) and the South Tianshan Domain (right).

Figure 2B - Stratigraphy of the West Siberian Basin, modified after Vyssotski et al. (2006).

Figure 2C - Position of the flood-basalts In the Anabar-Olenyok anticlinorium on the Siberian Craton, modified after Czamanske et al. (1998).





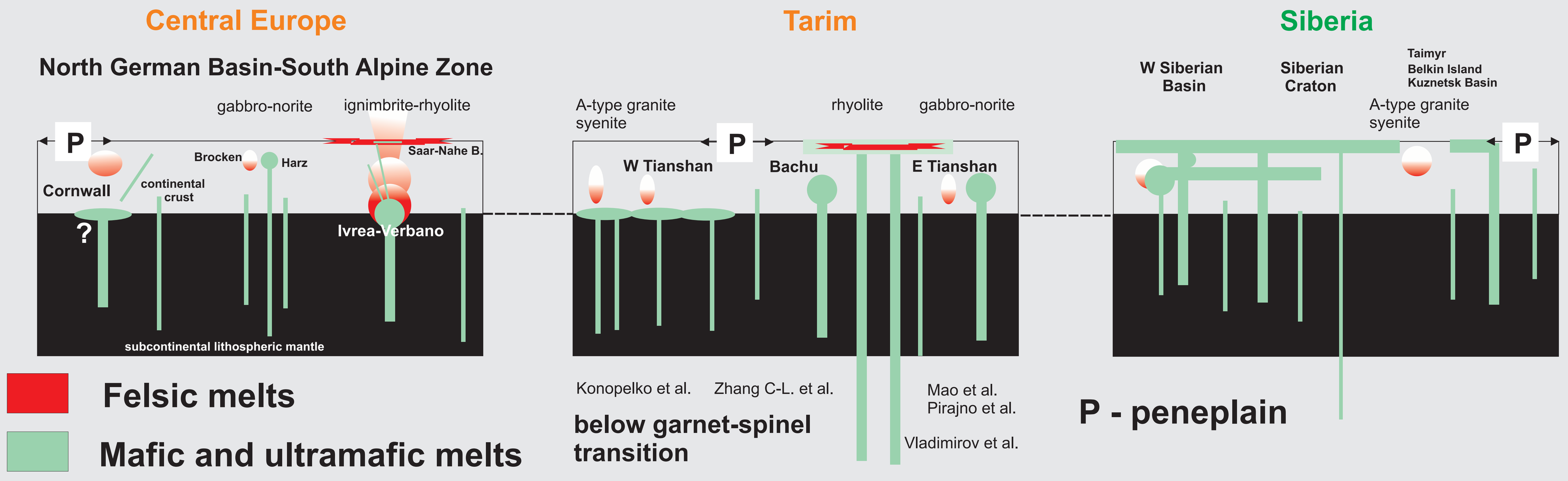


THE THREE LIPS AND THE ORE DEPOSITS DEVELOPED AFTER PENETRATIVE DEFORMATION AND METAMORPHISM IN THE BASEMENT HAD ENDED,

DURING CONTINUING STRIKE-SLIP DEFORMATION AND BASIN FORMATION,

IN A BRITTLE LITHOSPHERE, DURING AND AFTER EROSION AND UPLIFT OF THE OROGENIC DOMAIN.

Figure 3 INFERRED SOURCE DOMAINS OF THE THREE CONTINENTAL, LARGE IGNEOUS PROVINCES



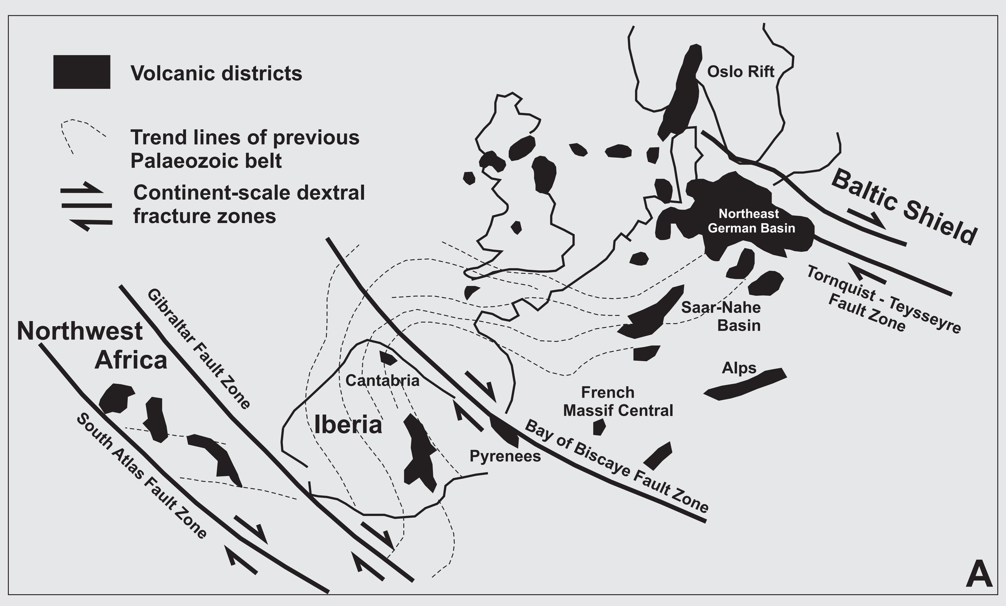
THE LIPS COMPRISE OF (ULTRA)MAFIC AND FELSIC VOLCANICS AND INTRUSIVES DERIVED FROM THE SUBCONTINENTAL LITHOSPHERIC MANTLE AND THE ASTHENOSPHERE.

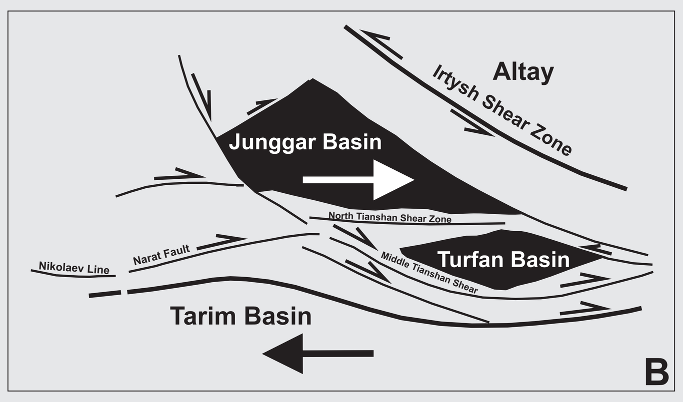
FELSIC PRODUCTS ORIGINATED FROM FRACTIONATION AND ANATEXIS IN THE LOWER CRUST.

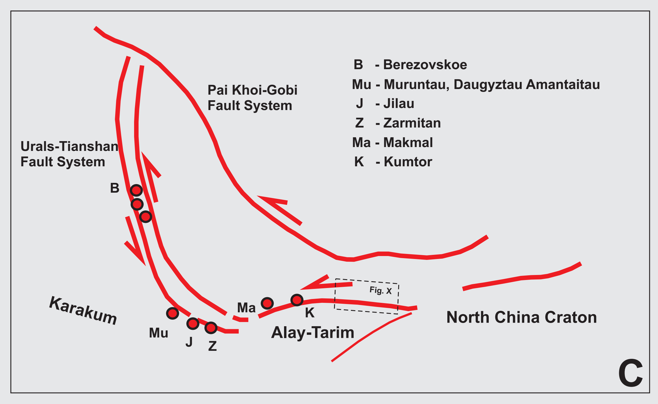
MINOR AND TRACE ELEMENTS, TOGETHER WITH ISOTOPES AND HYDROXYL-BEARING MINERALS SUGGEST EARLIER SUBDUCTION-ASSOCIATED METASOMATISM.

Figure 4 TECTONIC SETTING

Figure 4A - Principal Early Permian occurrences of the Central European LIP and first-order strike-slip fault zones between North Africa and the Baltic Shield (after Doblas et al., 1998).







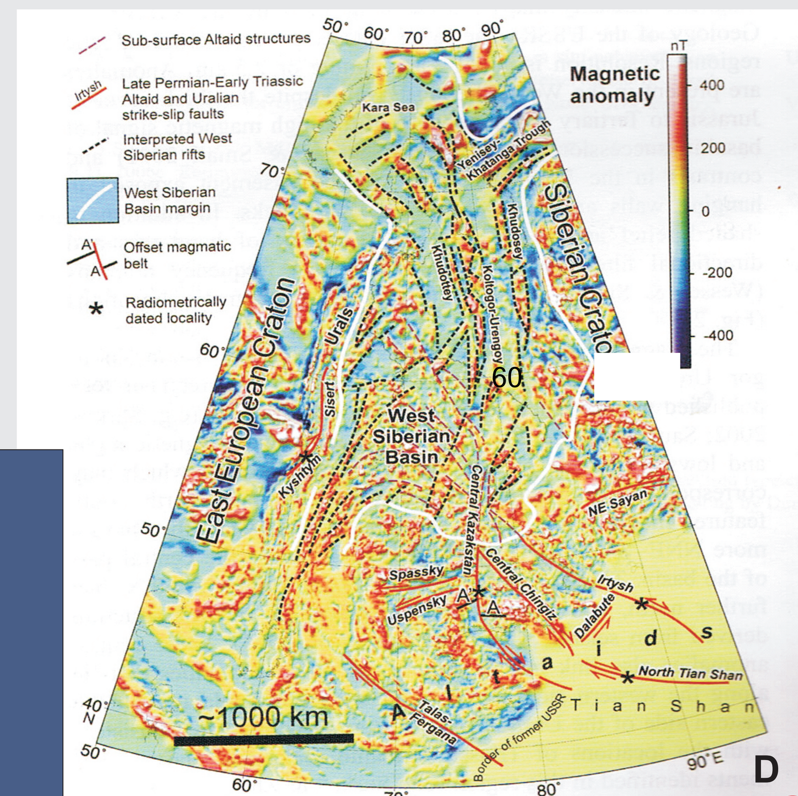


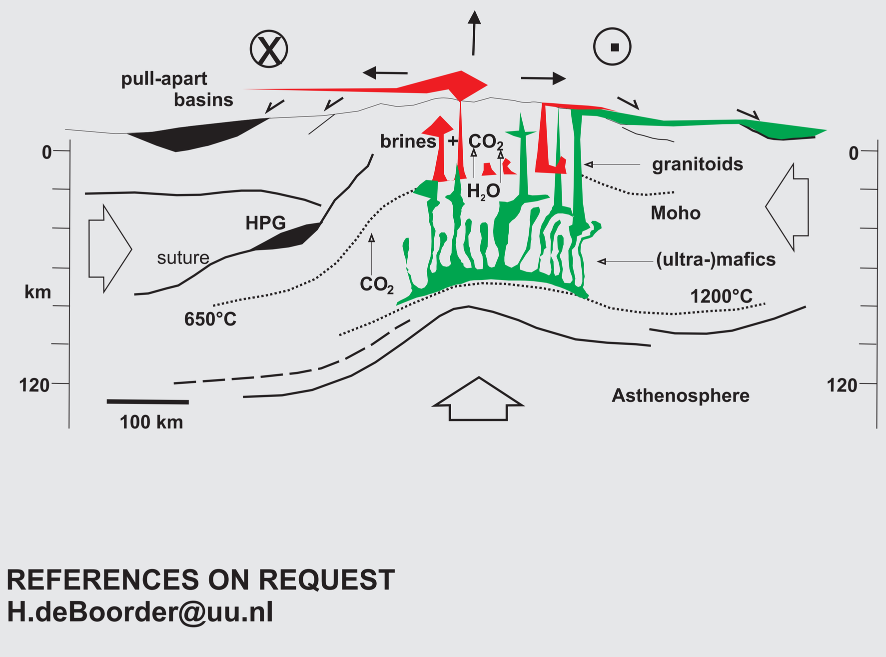
Figure 4B - Principal strike-slip fault zones north of the Tarim LIP (after Charvet et al, 2011).

Figure 4C - Principal Late Palaeozoic strike-slip framework in Central and Western Asia with world-class gold deposits (afterYakubchuk, 2004).

Figure 4D - Magnetic anomaly map of Western Siberia with interpreted strike-slip zones and pull-apart structures in the basement of the West Siberian Basin (after Allen et al., 2006).

ALL THREE LIPS INVOLVED CONTINENT-SCALE TRANS-LITHOSPHERIC STRIKE-SLIP DEFORMATION WITH ACCESS TO METASOMATISED DOMAINS IN THE SUB-CONTINENTAL LITHOSPHERE AND THE UPPER ASTHENOSPHERE

Figure 5 - Lithosphere-scale strike-slip deformation, pull-aparts, rifting, upwelling asthenosphere, decompression melting, variable volumes of (ultra)mafic melts, anatexis of lower crust, diverse ore deposits (after Leyreloup, 1992; De Boorder, 2012; De Boorder, submitted).



The ore deposits formed when the orogenic domains had been largely eroded to a peneplain (temporal distribution).

The subcontinental lithosphere of these domains had been metasomatised during earlier subduction (source).

By the time of ore formation, the orogenic domains constituted the suture zones between Laurussia, Gondwana and Siberia, while translithospheric strike-slip fault zones dissected the sutures in intra-continental deformation (tectonic setting).

Melting of metasomatised domains in the subcontinental mantle can, at that stage, only have been caused by decompression in extensional sectors of the strike-slip zones (geodynamic setting).

THE CONNECTING ELEMENT BETWEEN ORE DEPOSITS, LARGE IGNEOUS PROVINCES AND OROGENS WAS IN INTRA-CONTINENTAL, TRANS-LITHOSPHERIC STRIKE-SLIP DEFORMATION WHICH LOCALLY LED TO DECOMPRESSION MELTING.

WITHOUT DECOMPRESSION MELTING OF A METASOMATISED MANTLE THERE WOULD NEITHER BE LIPS NOR ORES.

FULL REFERENCES ON REQUEST
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