COMRA's Activities in Resources Assessment

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Features of COMRA's Area

- Western margin of CC zone;
- Consisting of two main parts being 200 km apart and spreading ~1,500 km from east to west;
- Variable grade and abundance of nodules and uneven topography;
- Deeper water depth, lower grade in west and lower abundance in east, comparing with others in CC zone.

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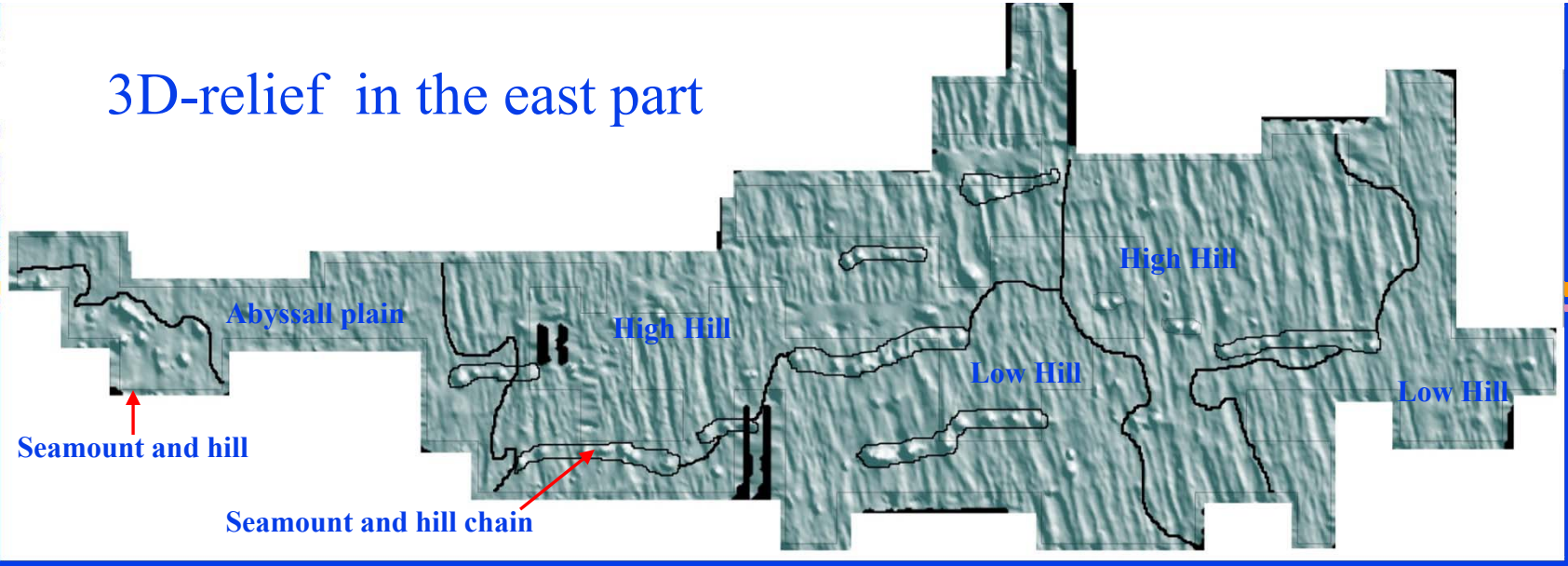
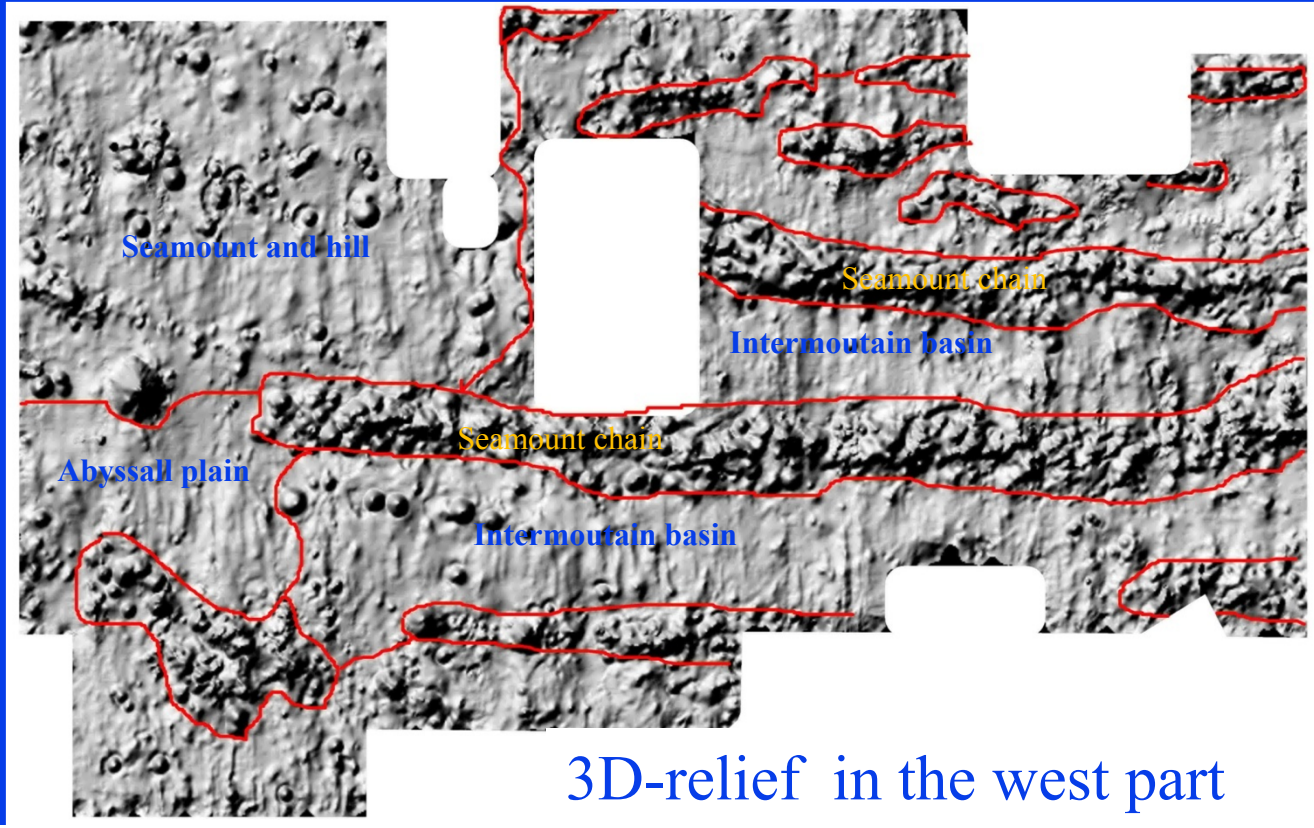
Topography of COMRA's Contract Area

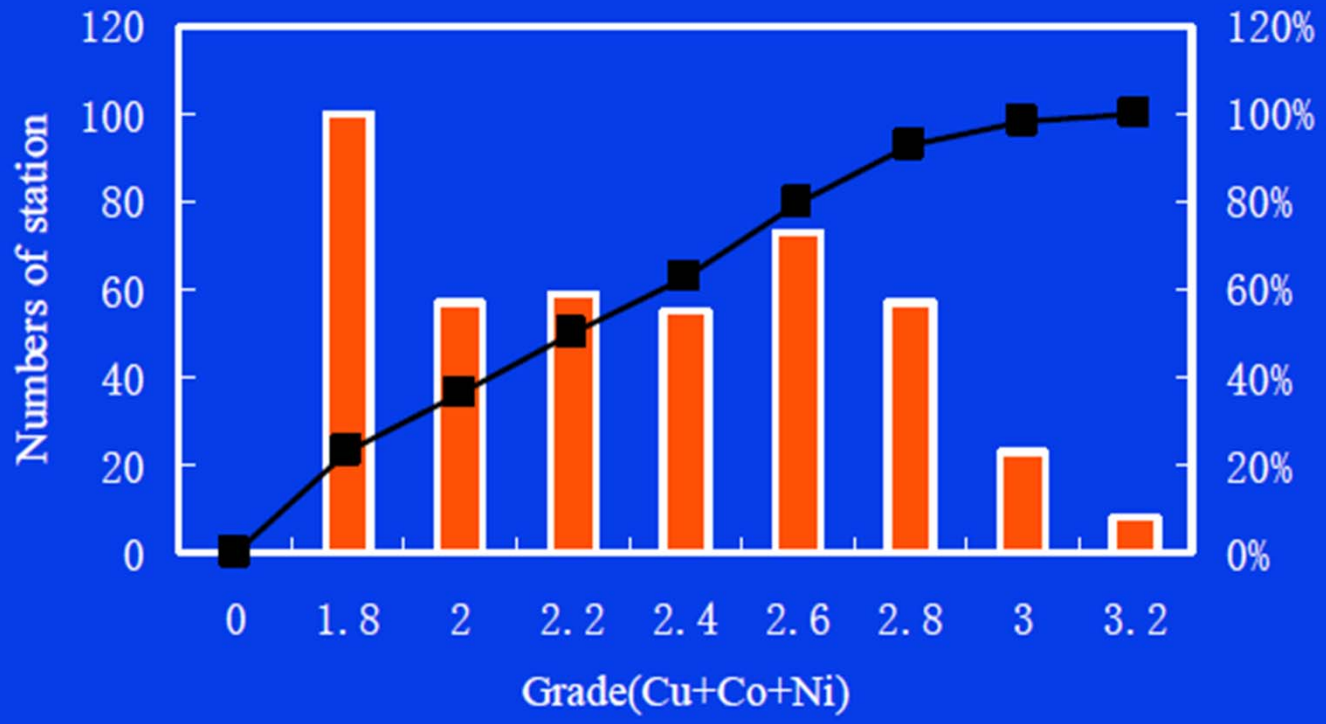
3D-relief in the east part





3D-relief in the west part

Distribution frequency of nodule grade in western part of contract area



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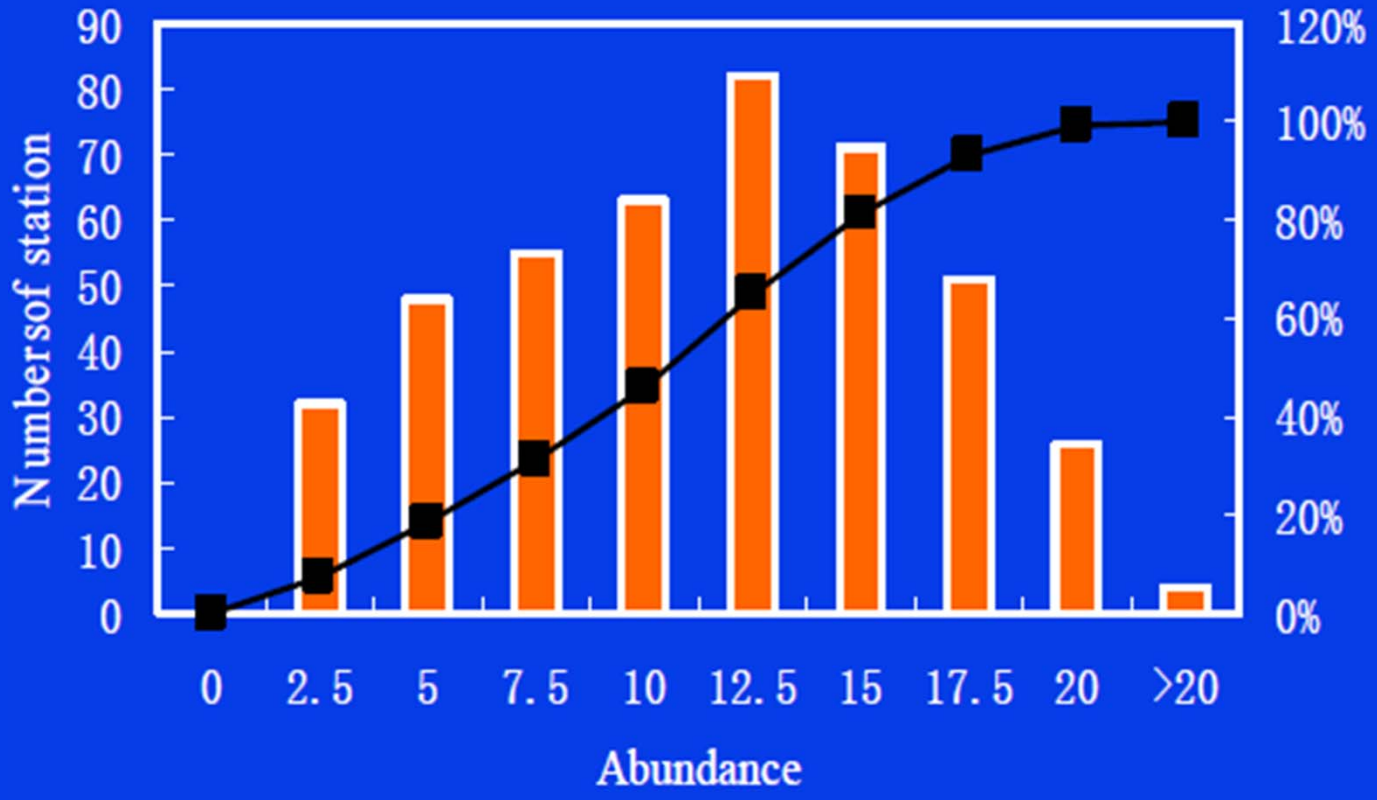
Distribution frequency of nodule abundance in western part of contract area



’Activities in Resources Assessment

- Exploration Strategy and Results
- Resource Assessment/classification in COMRA’s Contract Area
- Suggestion for Resource/reserve Classification

’Activities in Resources Assessment

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Exploration in the Contract Area

- To collect data and information for the purpose of
  - assessment of resources and environment impact on the site,
  - design of the test mining and processing systems

Resources Assessment & Exploration

- Resource assessment combined with exploration at sea is a process of upgrading the nodule resources and a process of delineating a mine site.
- Evaluating the quality, quantities, distribution and economic value of nodules in the contract area.

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Survey Equipment

Trapper of sediment

AUV (6000m)

HOV (7000m)

Camera and video

TV grab

Box sampler

Multi-core sampler

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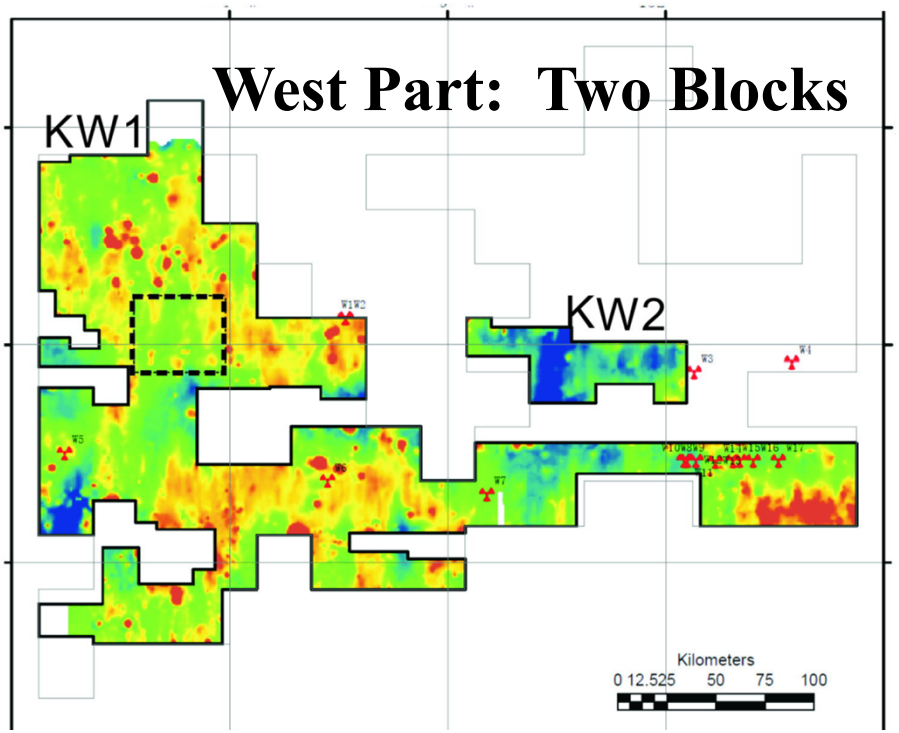
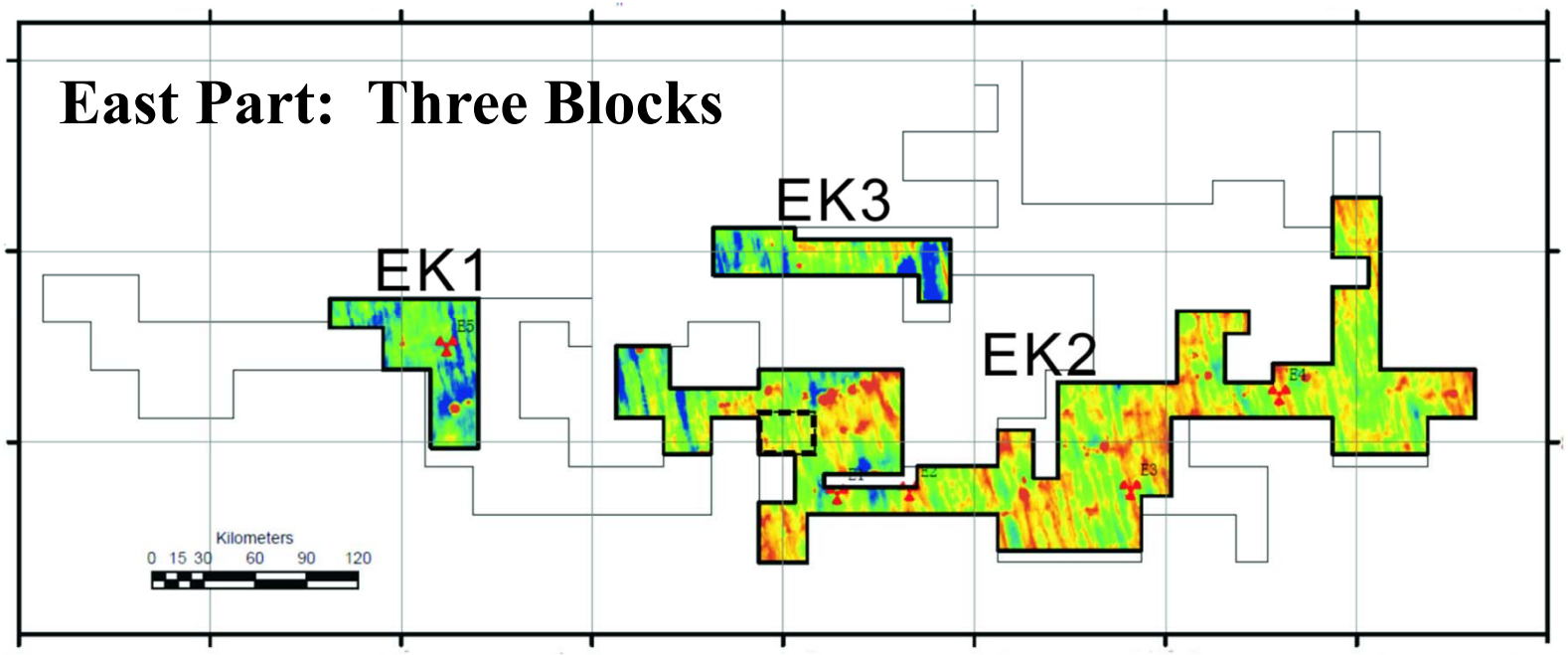
COMRA 's Contract Area

East + West parts=75000km^2





Blocks with potential deposit

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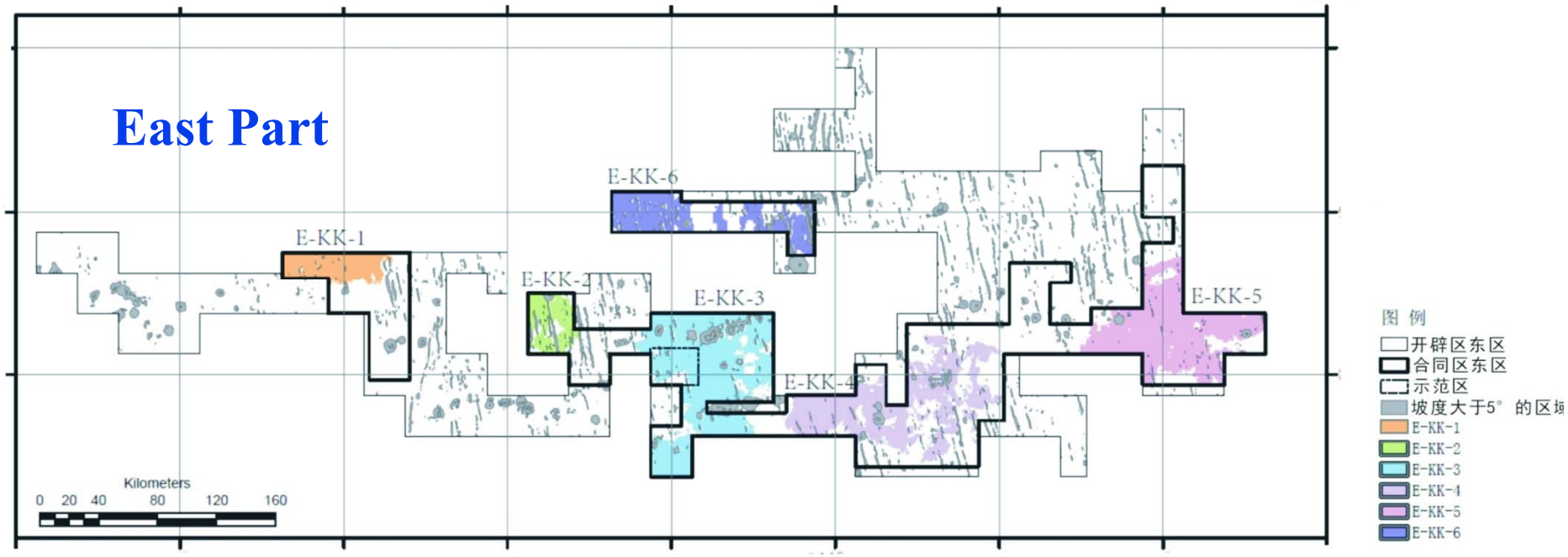
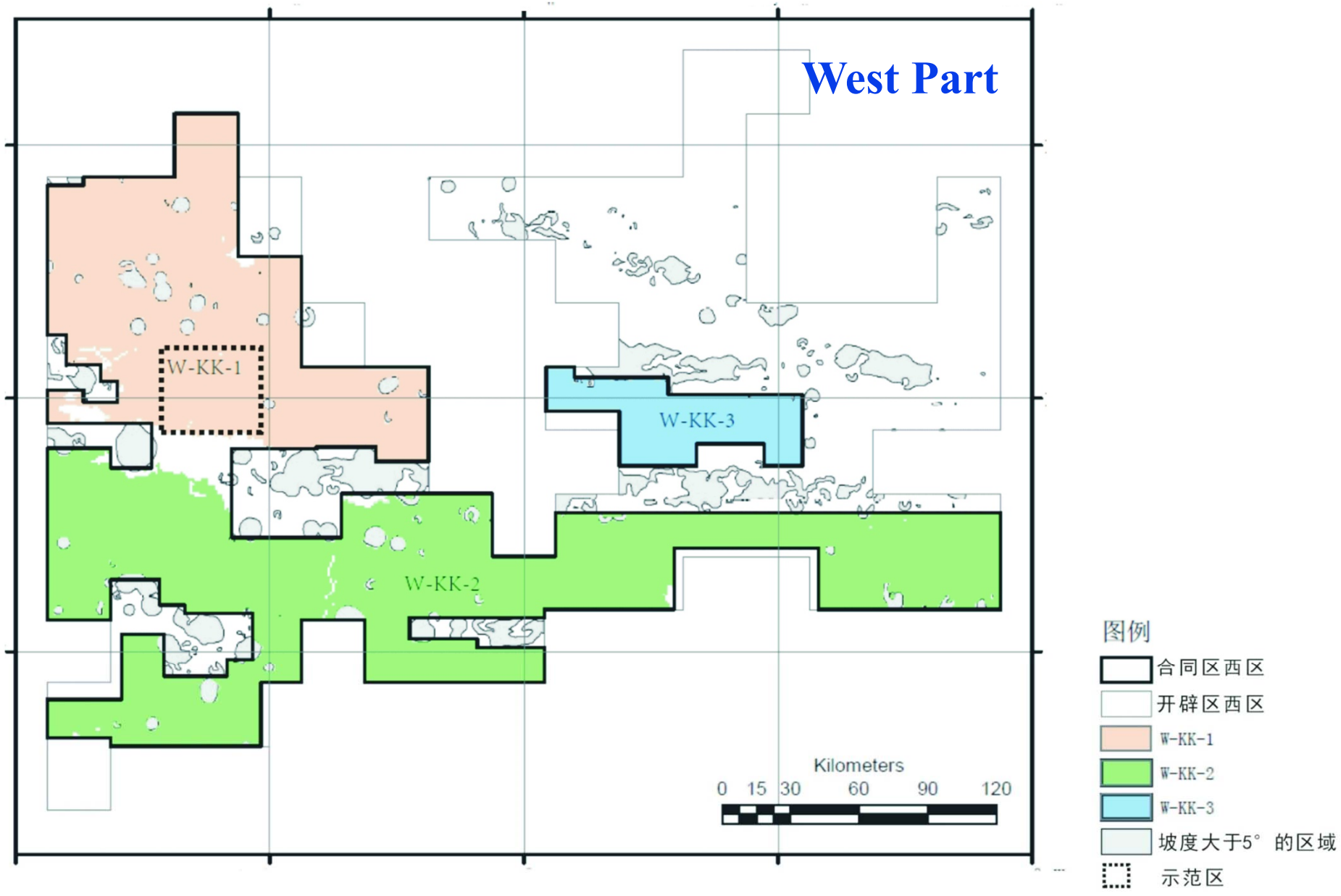
The resource amount of the nodule deposits was estimated by Kriging; 9 blocks were delimited:

6 in the east part of contract area

- **Abundance ≥5kg/m²**
- **Grade(Cu+Co+Ni)≥1.8%**
- **Slope≤5°**



3 blocks in the west part of contract area



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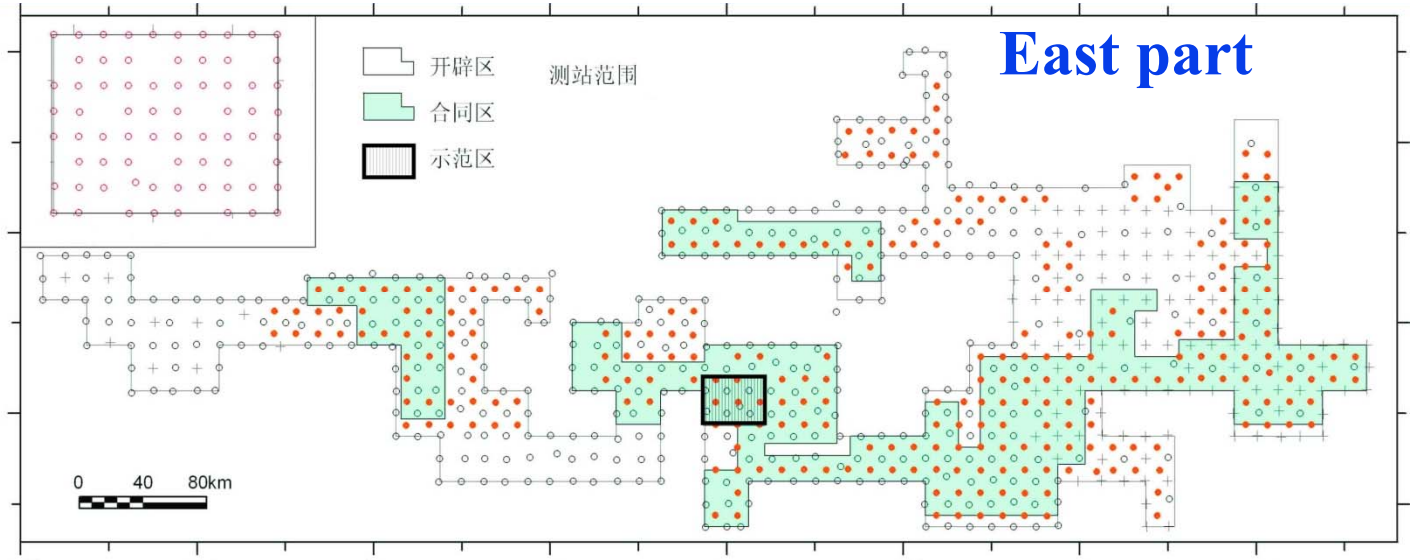
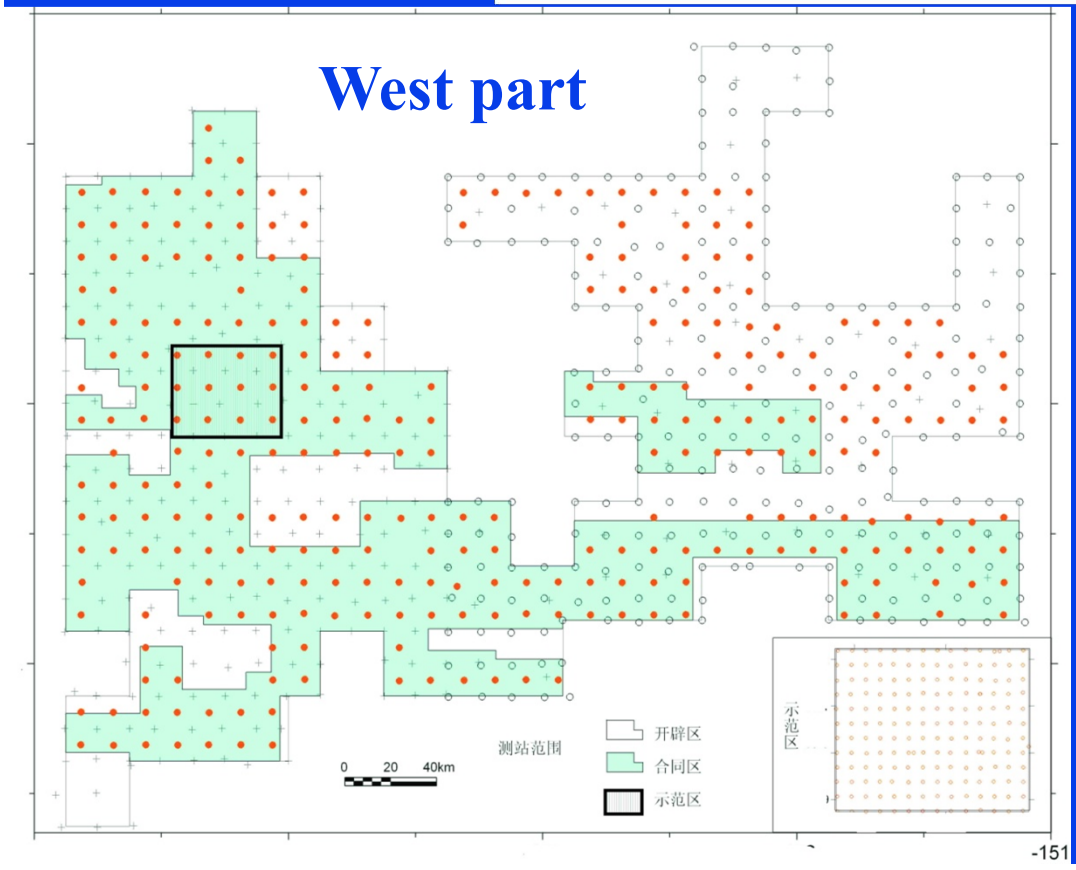
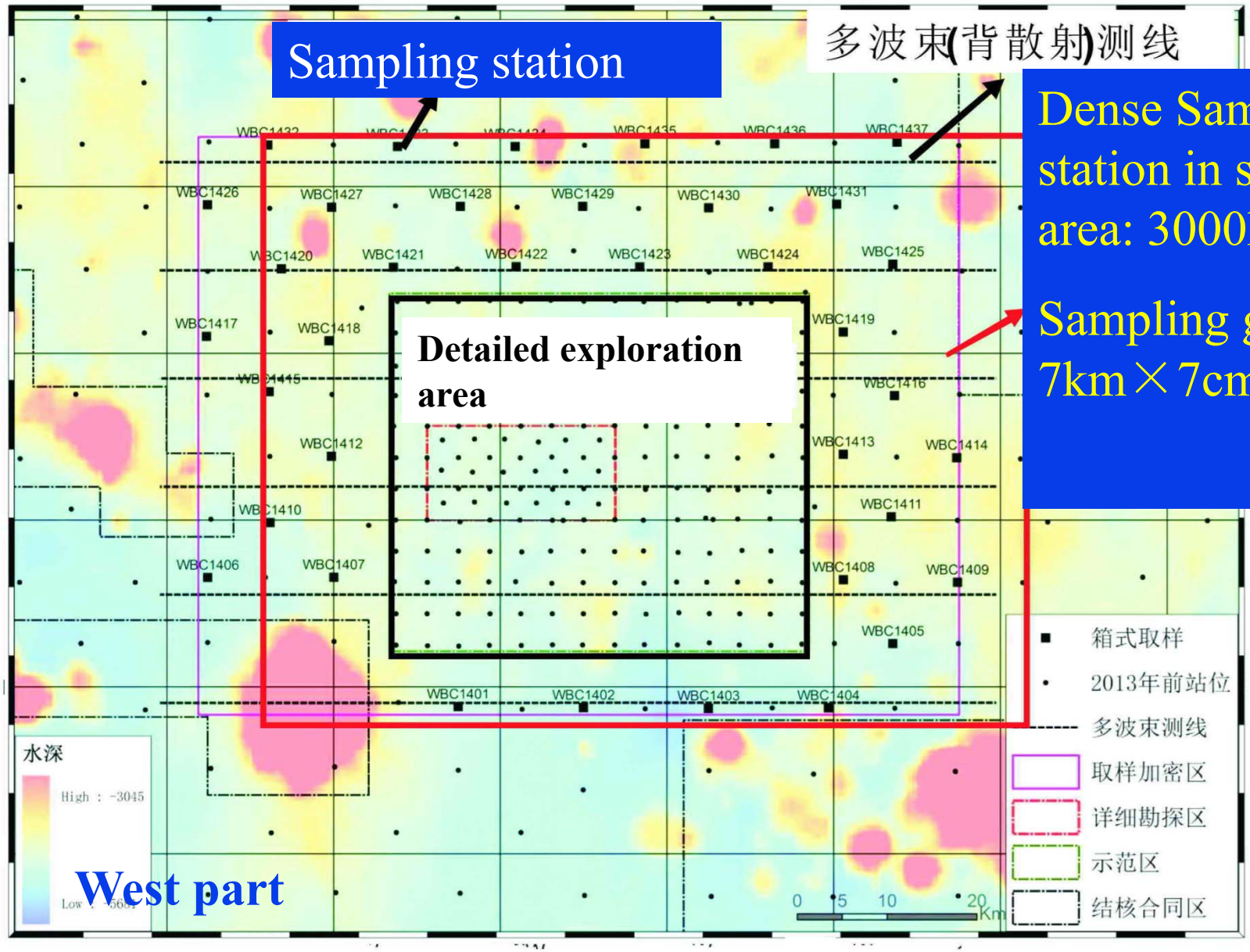




Main Sampling Grid:
5.3′×5.3′ (9.8km× 9.8km)

West part:
783 sampling stations

East part:
849 sampling stations


Sampling station
多波束(背散射)测线
Dense Sampling station in selected area: 3000km²
Sampling grid: 7km×7cm
Detailed exploration area
West part
WBC1426
WBC1427
WBC1428
WBC1429
WBC1430
WBC1431
WBC1420
WBC1421
WBC1422
WBC1423
WBC1424
WBC1425
WBC1417
WBC1418
WBC1419
WBC1412
WBC1413
WBC1414
WBC1410
WBC1411
WBC1406
WBC1407
WBC1408
WBC1409
WBC1405
WBC1401
WBC1402
WBC1403
WBC1404
水深
High : -3045
箱式取样
2013年前站位
多波束测线
取样加密区
详细勘探区
示范区
结核合同区
0 5 10 20
Km

Dense sampling in a selected area in west part of contract area

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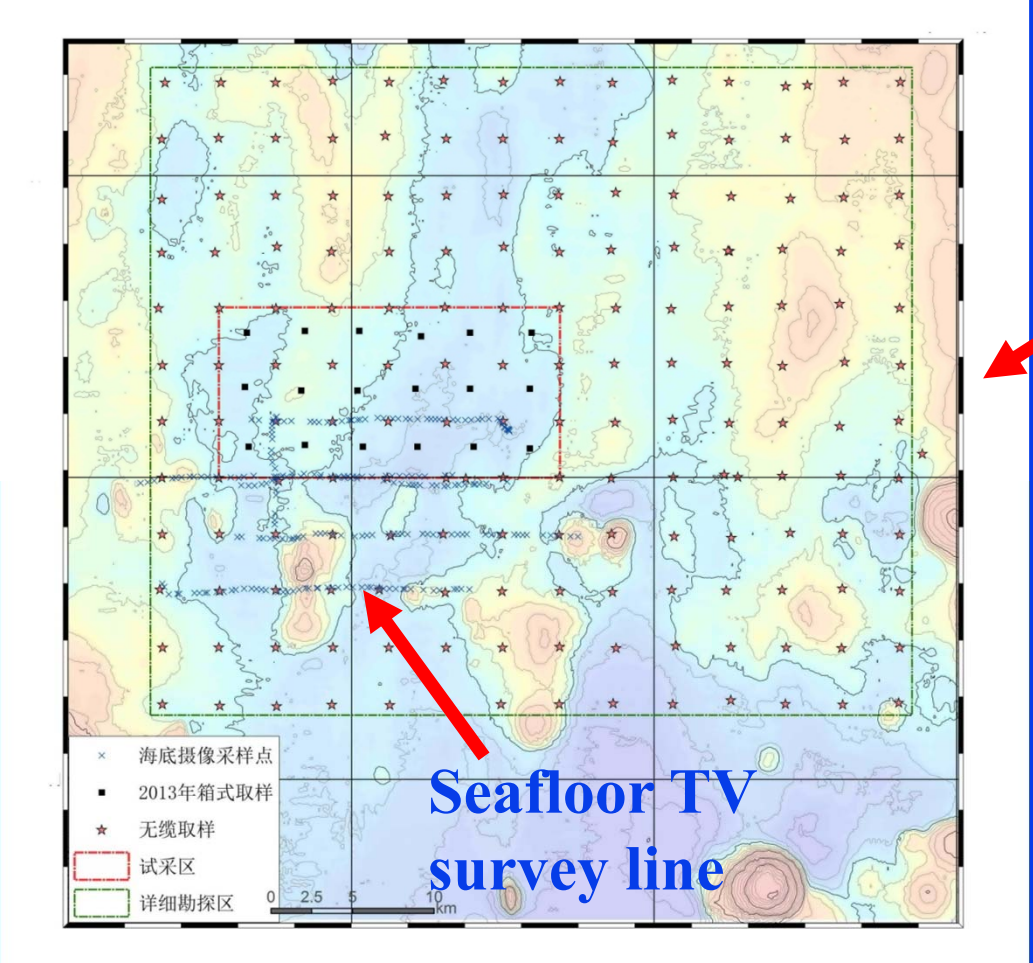

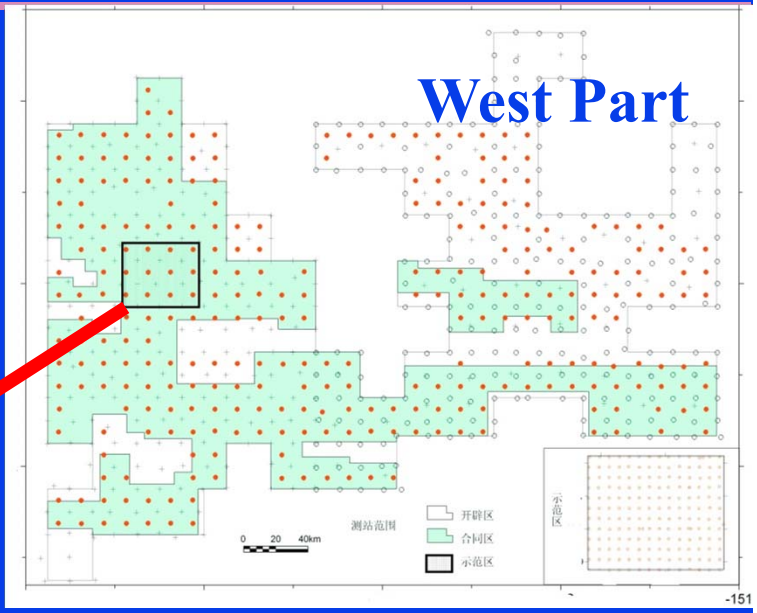

Sampling Grid
in selected area(1800km^2)
1.875′×1.875′
(3.5km× 3.5km)

Sampling stations: 173

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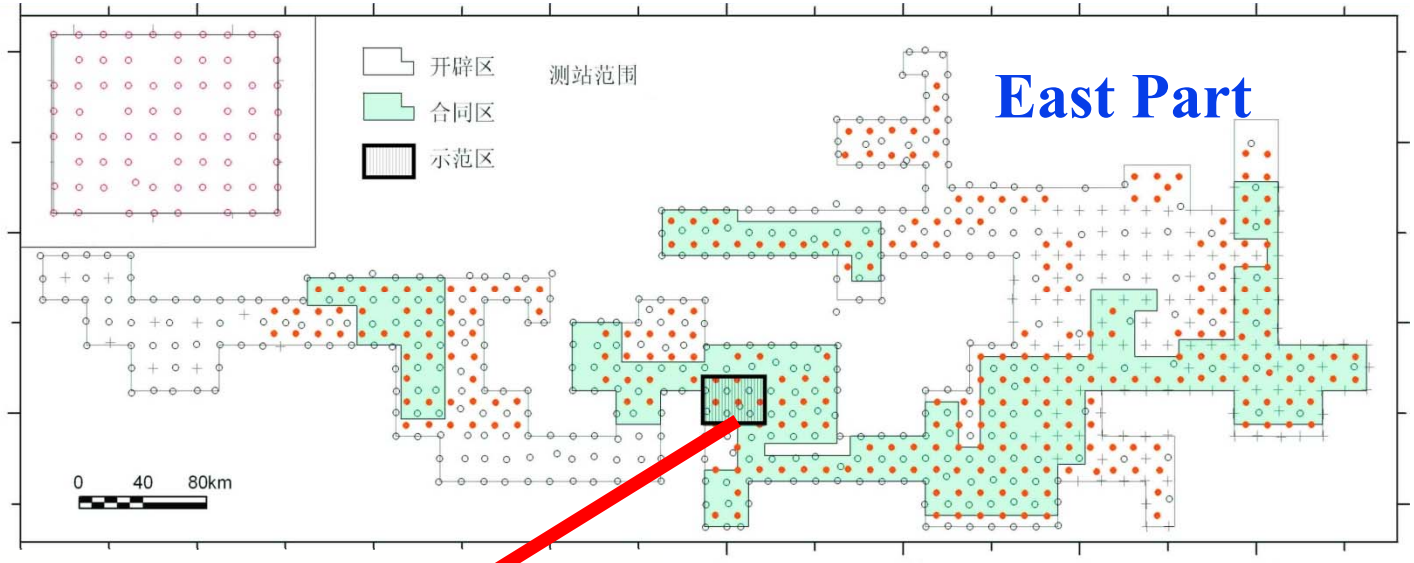

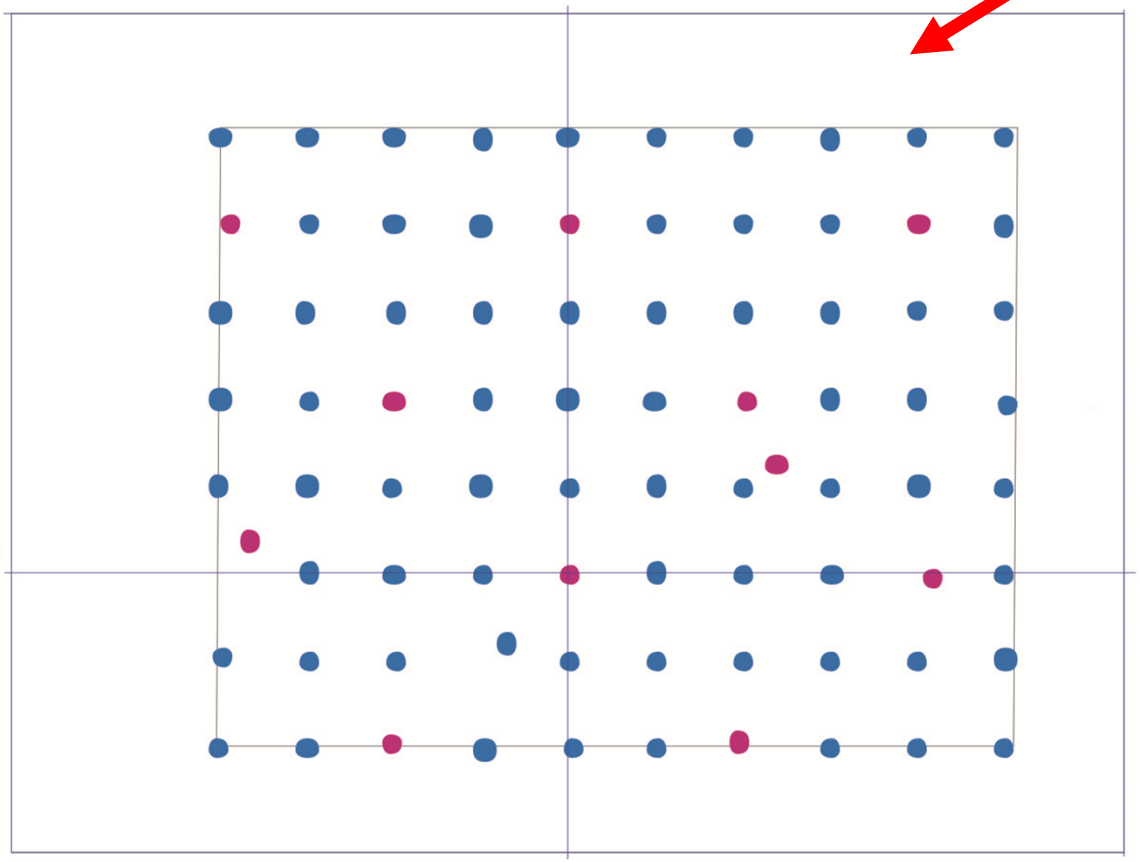

Sampling Grid
in selected area(773km^2)
1.875′×1.875.3′
(3.5km× 3.5km)

Sampling stations: 80

- An area, sizing 217km^2 , with flat terrain within the 1800km^2 was selected for future environmental impact assessment together with equipment testing;
- Dense sampling and AUV measurements were carried out in this area:
  - Geological sampling stations: 18
  - AUV survey area: 120km^2

Topography around the area for future environmental impact assessment and equipment test

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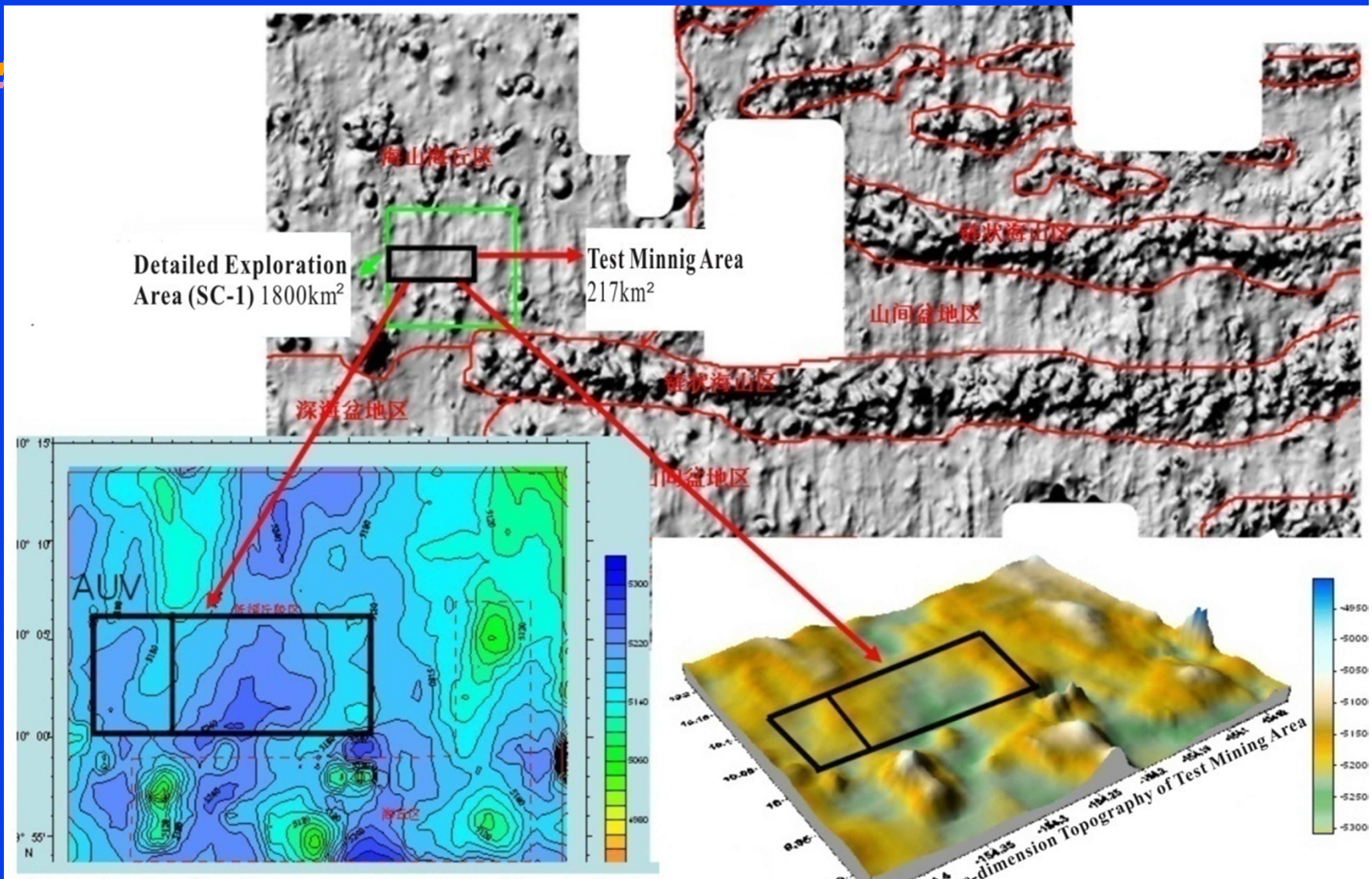

Detailed Exploration Area :low and gentle hills with water depth 5020m-5306m,Rough terrain in the south east part with 5 low hills, the height of the hills 200m-300m.

Test Minnig Area:
flat terrain easy for mining

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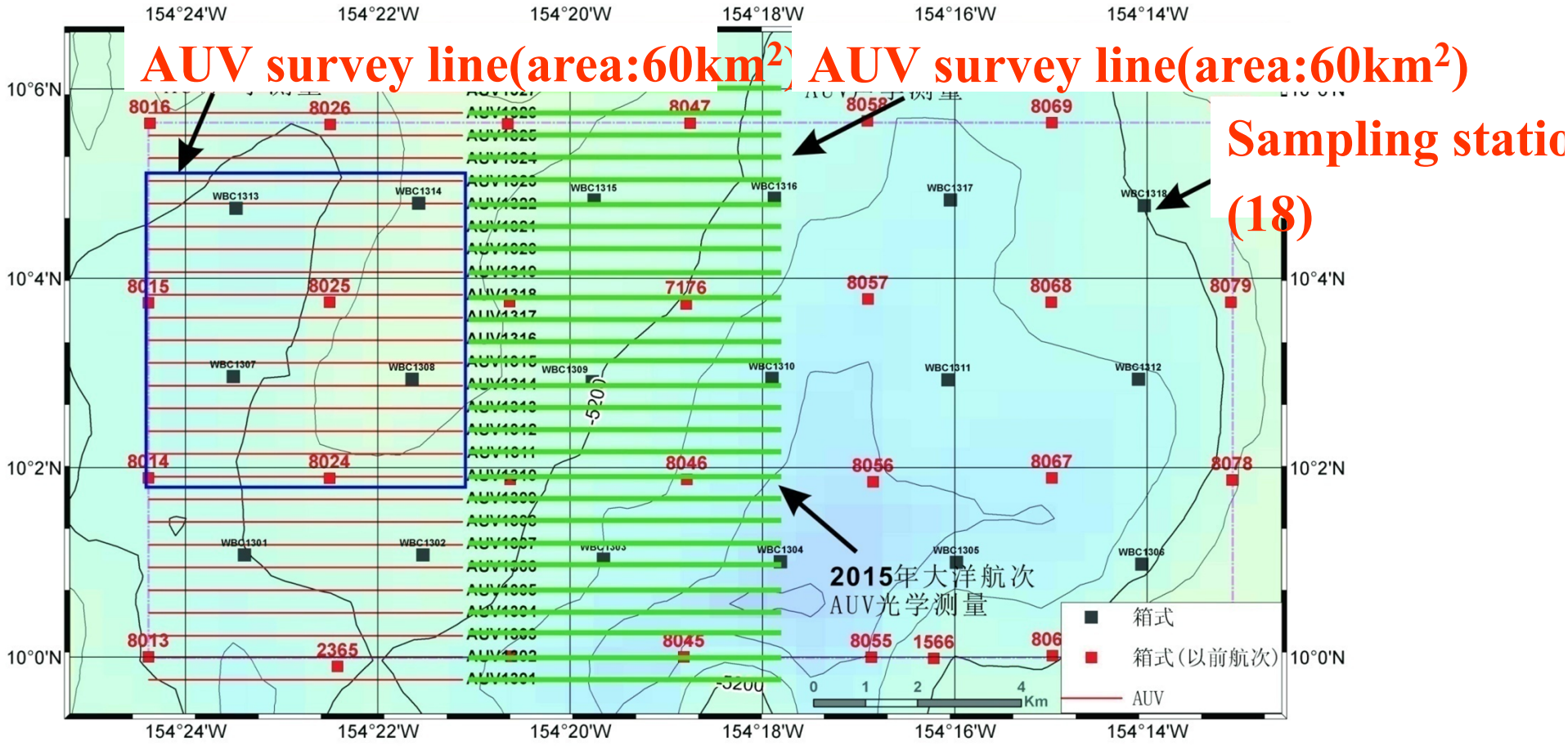
Layout of AUV survey lines and box core sampling stations in this specific area from 2013 to 2015



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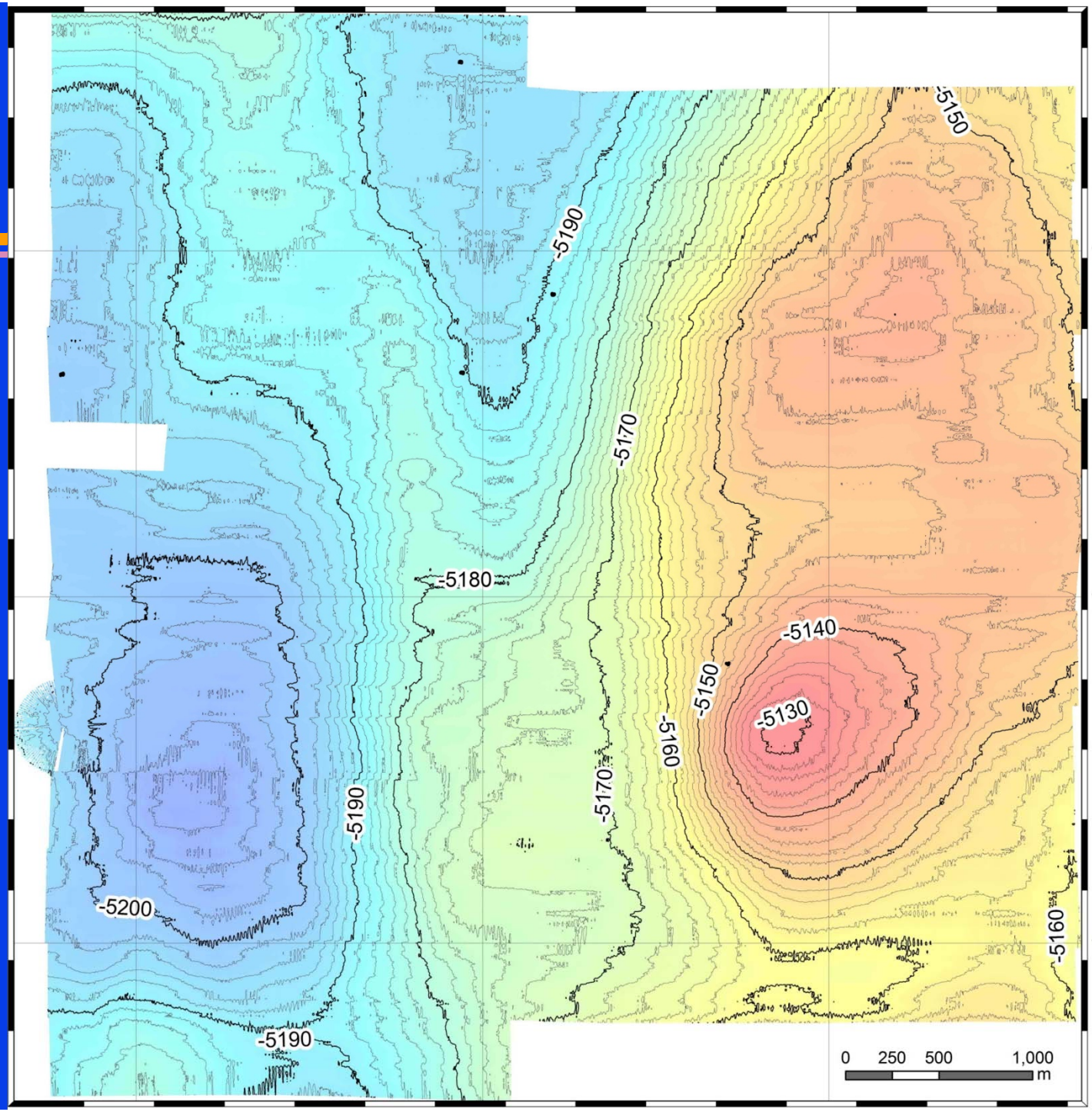
The bathymetry measured by AUV in this specific area (isobath of 2m interval)



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Geological factors

- Area with potential deposit:
  - tectonic features, topography, regional strata, types and features of the surface sediment, regional rift structure;
- Deposit:
  - distribution and coverage features of the polymetallic nodule;
- Ore:
  - types and mineral features of the nodule.

Environmental factors

- **Hydrological and meteorological**
- **Shape and integrity** of ore-fields and size of ore-field blocks
- **Topography of seafloor**, variation of slop and the obstacle.
- **Feature of the deposit and ore,** including the hardness, size and porosity of nodules
- **Geotechnics of sediments,** including the solidness, shear strength and grain size
- **Ecosystem** and its sensitive to the operation system

Commercial factors

- Investment and the operation cost related to the collecting, recovery, transportation and processing of the nodules;
- Variation of price for the metals possibly recovered from the nodules;
- Rate of return.

Main economic indexes to delimit area with potential deposit

- Average boundary abundance: $\geq 5.0 kg/m^2$
- Average boundary grade: (Cu+Co+Ni)≥1.80%;
- Sea-floor topographic slope <5°;
- Solid bottom sediments

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Resource classification in west part of COMRA's contract area

Area	Sampling Grid	Resource Categories
Area with potential deposit: 56000 km^2	9.8km × 9.8km	Inferred Resources
Area in dense sampling: 3000 km^2	7km × 7km	Indicated Resources
Area with further exploration: 1800km^2	3.5km × 3.5km	Measured Resources
Area for specific use: 217km^2	2.5km × 2.5km	Measured Resources

Resource classification in west part of COMRA's contract area

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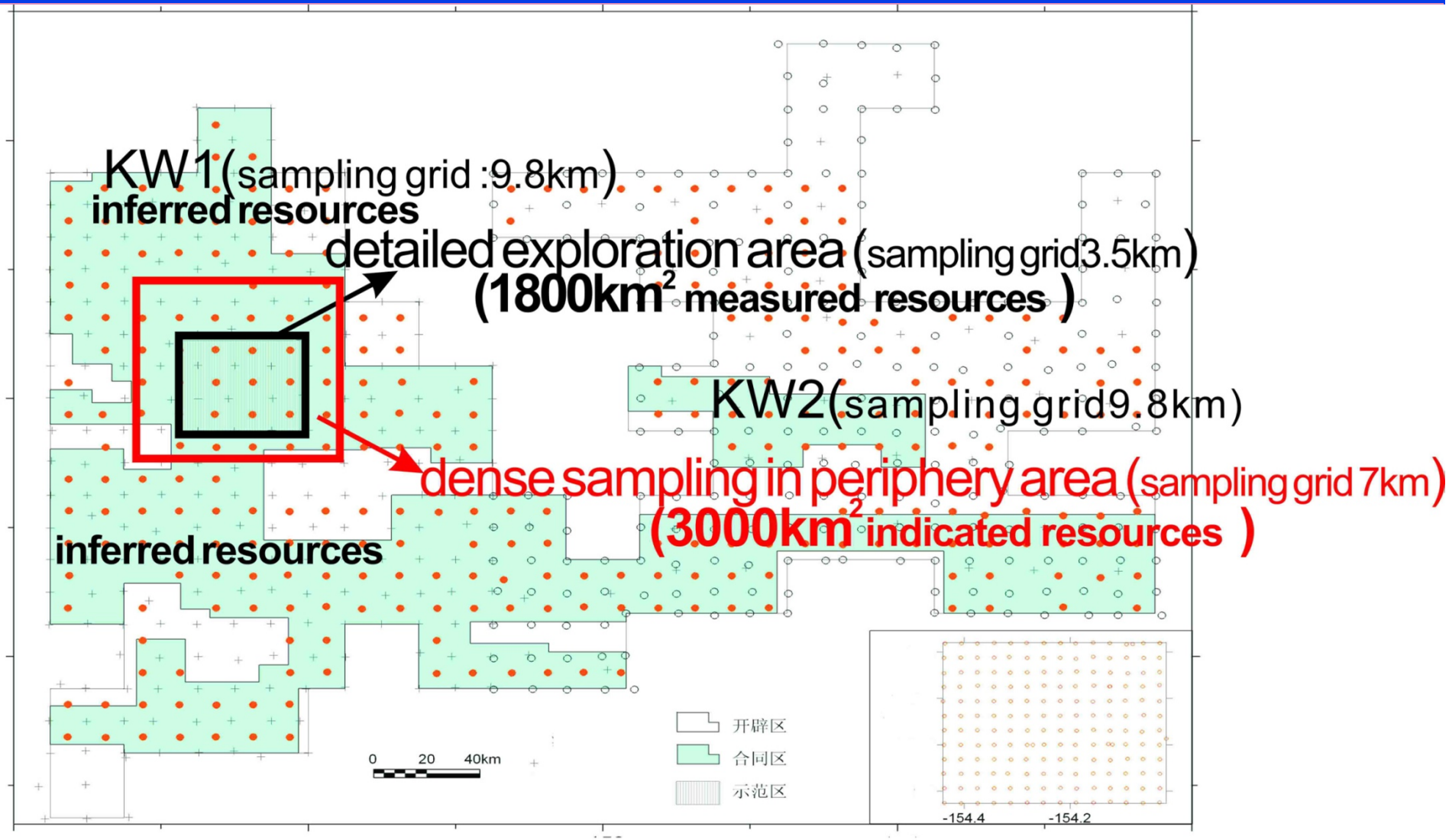

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Resource Classification used by COMRA from China (GT 1776-1999) based on UNFC 1997

Resource/reserve / Economic viability	Measured	Indicated	Inferred	Predicted
Economic	Proved reserves (111)			
	Probable reserves (121)	Probable reserves (122)		
Intrinsically economic	Measured resources(331)	Indicated resources (332)	Inferred resources (333)	Predicted resources 334

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Comparison in resource classification between COMRA and CRIRSCO

COMRA Classification		CRIRSCO Taxonomy
Predicted resources 334?	⟺	Exploration results
Inferred resources 333	⟺	Inferred Mineral Resource
Indicated resources 332	⟺	Indicated Mineral Resource
Measured resources 331	⟺	Measured Mineral Resource
Probable reserves 121	⟺	Probable Mineral reserve
Probable reserves 122		
Proved reserves 111	⟺	Proved Mineral Reserve

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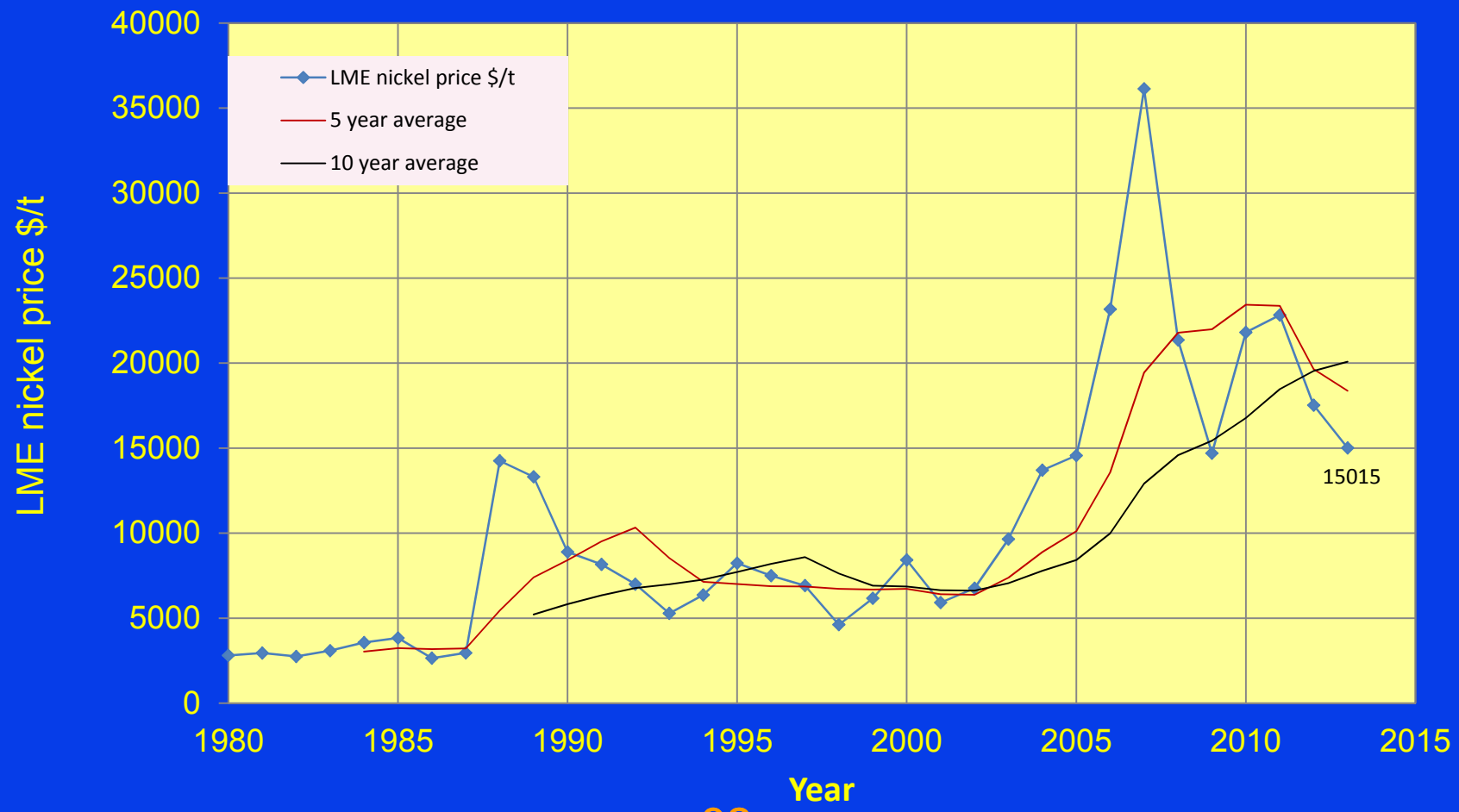
Nickel Price

Price in 2013 : 15015$/t
Average of last 5 years : 18376$/t
Average of last 10 years : 20082$/t



Source :LME

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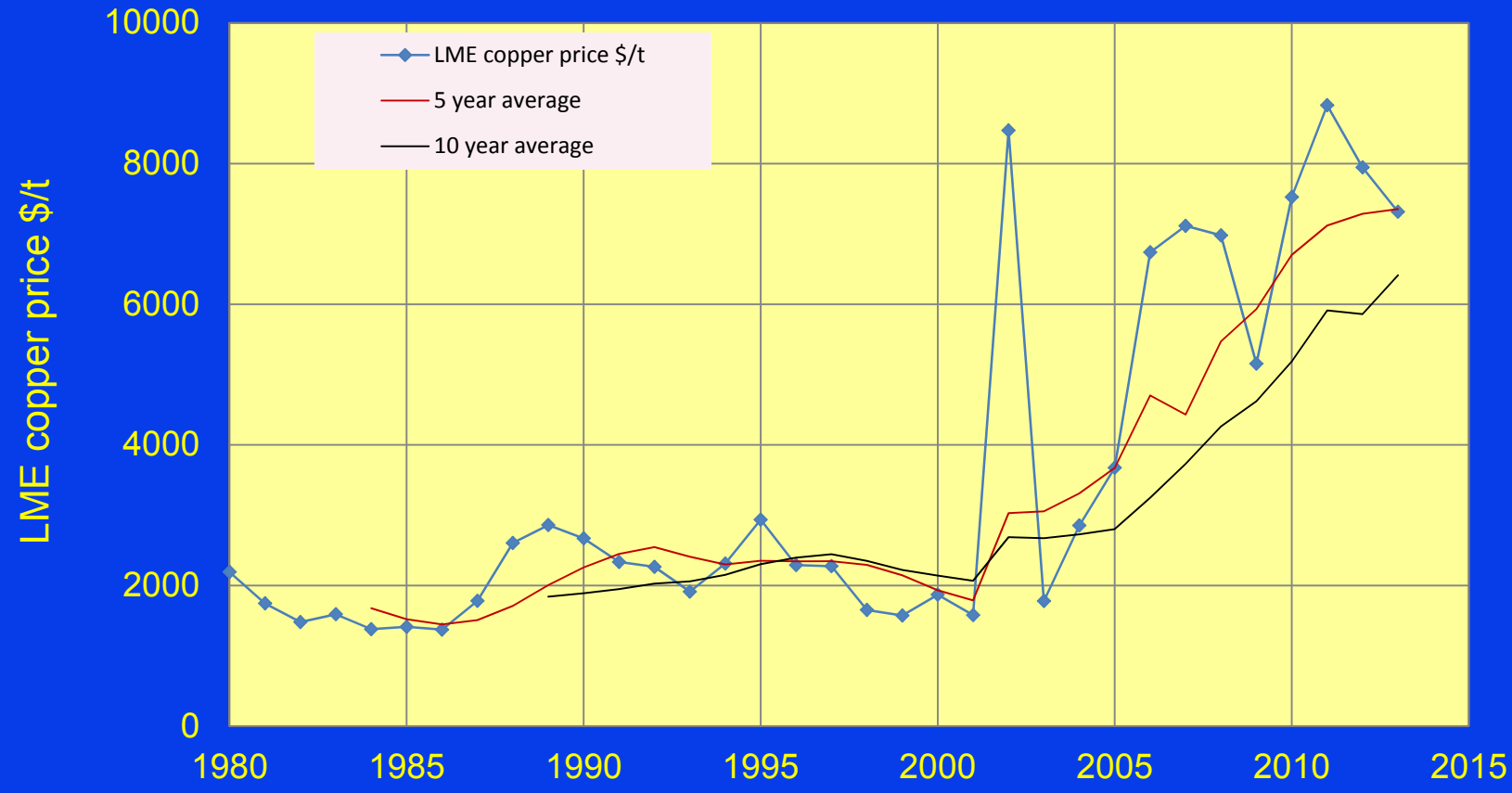
Copper Price

Price in 2013 : 7314$/t

Average of last 5 years : 7353$/t

Average of last 10 years : 6413$/t



Source :LME

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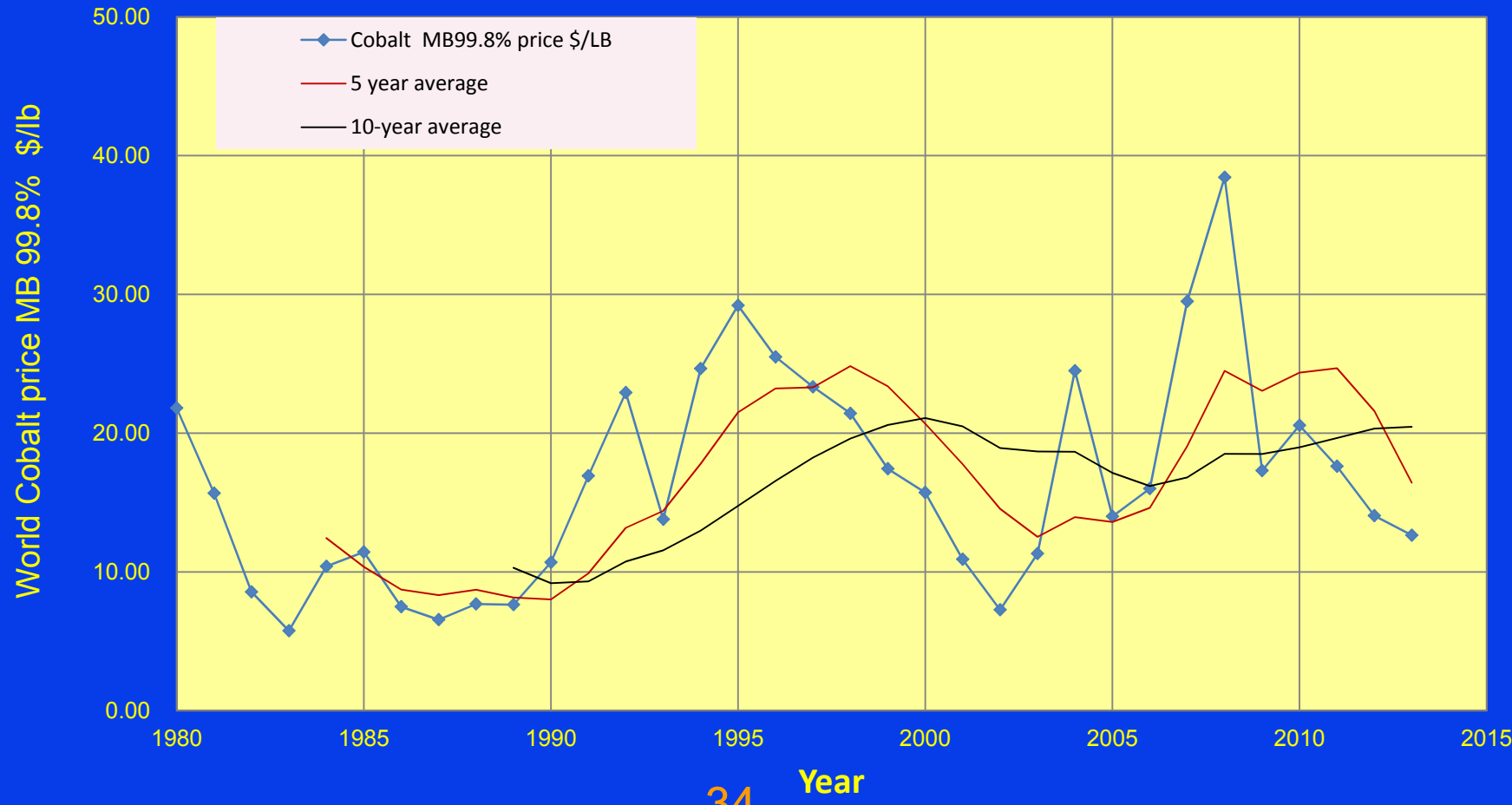
Cobalt – Price

Price in 2013 : 12.65$/lb

Average in last 5 years : 16.43$/lb

Average in last 10 years : 20.46$/lb



Source :Metal Bulletin

China's economic structural improvement and upgrading

- In industries with severe overcapacity, we will strengthen environmental protection, energy consumption, and technology standards; abolish preferential policies; absorb some excess production capacity and strictly control increases in production capacity. This year, we will reduce outdated production capacity of 27 million metric tons of steel, ……

From Report in 2014 by Premier Li Keqiang of China

Structure of a seabed mining project
--from report of UN expert group in 1989

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Possible duration	Early period	R & D (7-10y)	Feasibility (2-3y)	Construct (4-6y)	Production (20y)
Exploration	Prospecting	Exploration Stage I & II	Reserves	Mining preparation	.....
Mining	Concepts	Pilot tests	Further tests?	Mining equipment	Start up ....
Processing	Approaches	Pilot plant	Further tests?	Processing plant	
Marketing	Products	Supply/ Demand	Update	Sales contracts	
Financial		Analysis	Analysis	Monitoring	
Management		Decision to proceed	Decision to start	Ongoing decision	

Relationship between Structure of a seabed mining project and resource classification

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Possible duration ..... →	Early period	R & D (7-10y)	Feasibility (2-3y)	Construct (4-6y)	Production (20y)
Exploration	Prospecting	Exploration Stage I & II	Reserves	Mining preparation ..... →	
Mining	Concepts	Pilot tests	Further tests?	Mining equipment	Start up .... →
Processing	Approaches	Pilot plant	Further tests?	Processing plant	
Marketing	Products	Supply/ Demand	Update	Sales contracts ..... →	
Financial		Analysis	Analysis	Monitoring ..... →	
Management		Decision to proceed	Decision to start	Ongoing decision ..... →	
Categories of resource/reserves	Resources	Resource/ reserves	Reserves		

Report of LTC Chairman in 12th session of ISA
---ISBA/12/C/8 August 2006

- Consideration of a proposal to establish a mineral resource/reserve classification system for the Area
  - LTC noted the need for a classification for the Area. Debate ensued as to the suitability for the resource/reserve of the Area of those existing systems which have been specifically designed to have global applicability, for example, UNFC. It was agreed to retain the proposal for further discussion in order to make it available for use by the Commission as and when required for the resource/reserve of the Area.

Proposal of mineral resource/reserves classification with the exploration results

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Resources/reserves Categories	Exploration Grid	Exploration Methods and Requirements	Exploration Results reflecting by Maps
Inferred resources (333)	10～25km	geological sampling, multi-beam survey, shallow profiling, single channel reflection seismic survey	1:1,000,000～1:500,000 Original data, Topographic…
Indicated resources (332)	5～7km	geological sampling, multi-beam survey, shallow profiling, single -channel reflection seismic survey, geotechnical property measuring on shipboard , and other geophysical survey methods	1:500,000～1:250,000 Original data, Topographic, Geological, Abundance and grade, Resource distribution…
Measured resources (331)	2.5～3.5km	geological sampling, deep-tow survey, AUV survey, geotechnical property measuring in situ, other geophysical survey methods fast to obtain the accurate topography and landform and distribution on nodules.	1:250,000～1:100,000 Original data, Topographic, Landform , Geological, Abundance and grade, Resource distribution…
Reserves	……	…….	……

Thank You for Your Attention!