

Geological Settings and Formation of Jade

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Definition of Jade

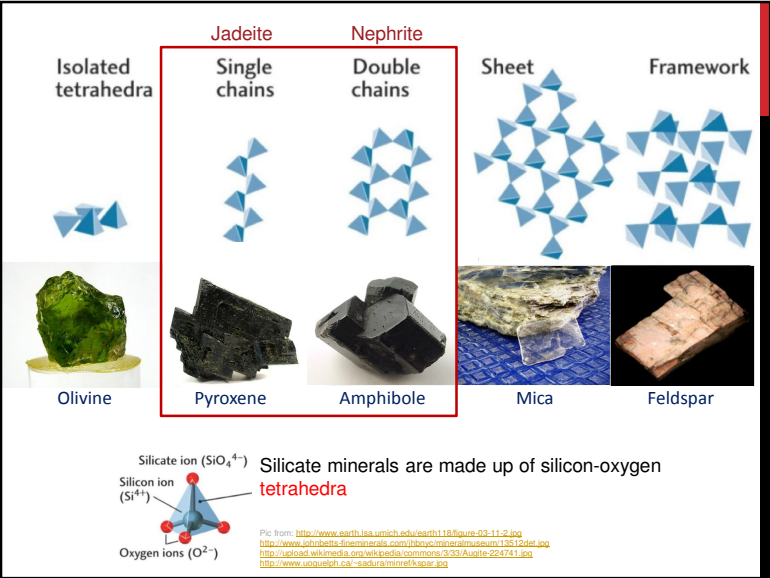
- 'Jade' is being used commonly in jewellery market
- Authentic jade refers to 2 different silicate minerals
 - Jadeite (硬玉) and Nephrite (軟玉)
 - Jadeite is more valuable and rarer than Nephrite
- A lot of nicknames misrepresent jade
 - For example: mountain jade, new jade, olive jade, white jade, snow jade, African jade, Indian jade, Malaysian jade, Suzhou jade, etc...
 - They are not a real Jadeite or Nephrite



Authentic Jade

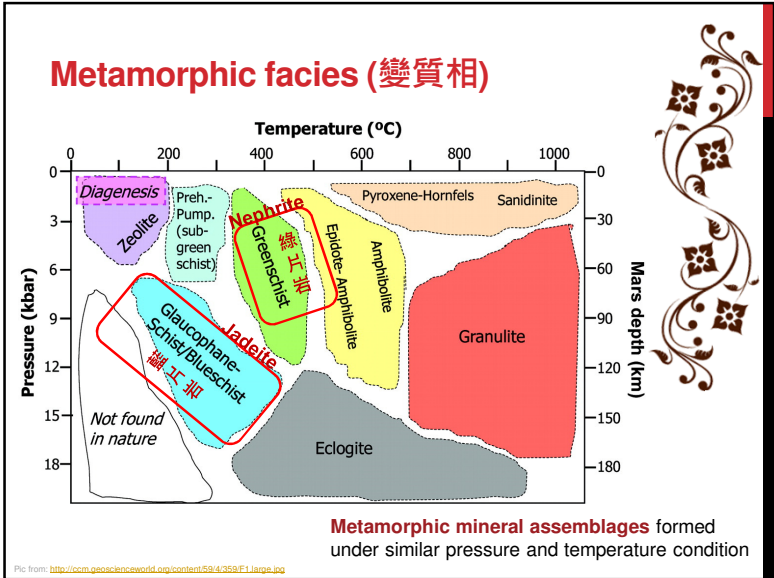
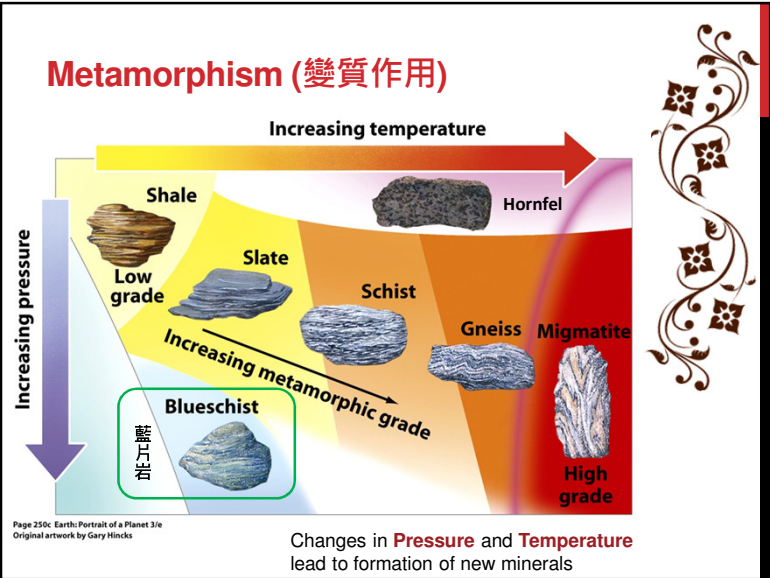
- Jadeite (硬玉): $\text{NaAlSi}_2\text{O}_6$
 - Is a kind of sodium and aluminium rich Pyroxene (輝石)
 - Imperial jade or 'Fei Tsui' (翡翠) is the best quality jadeite of strong emerald-green colour
 - Most jadeites are from Myanmar
- Nephrite (軟玉): $\text{Ca}_2(\text{Mg,Fe})_5\text{Si}_8\text{O}_{22}(\text{OH})_2$
 - Is a kind of Amphibole (閃石)
 - Fibrous variety of Actinolite (陽起石) and Tremolite (透閃石)
 - Traditional Chinese jades are Nephrites or other minerals

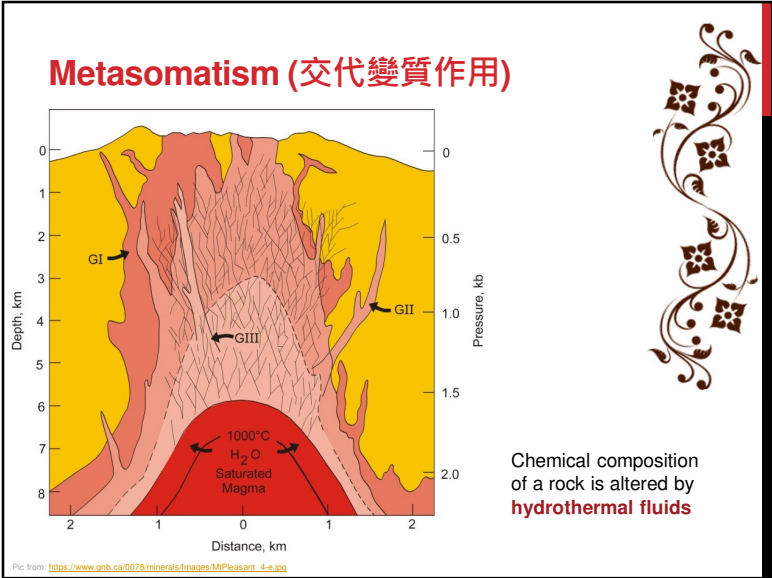




Geological Processes that form Jadeite and Nephrite

- Metamorphism (變質作用)
 - Metamorphic facies
- Metasomatism (交代變質作用)
- Serpentinization (蛇紋岩化)





Serpentinization (蛇紋岩化)

- Is an alteration process which ultramafic rocks (low silica) are changed upon the influence of water
- Peridotite (橄欖岩) oxidizes to Serpentinite (蛇紋岩)

Jadeite

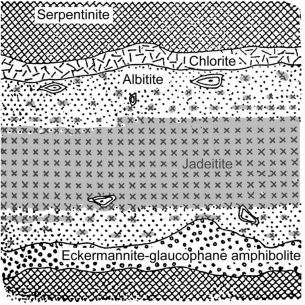
Geological Setting of Jadeite

- High Pressure and Low Temperature condition
- Subduction zone (Convergent plate boundary)
- Associated with Blueschist facies

pic from: http://www.sepmiata.org/CMS_images/Contributed/AppGeoStrum/colomard_01

Genesis

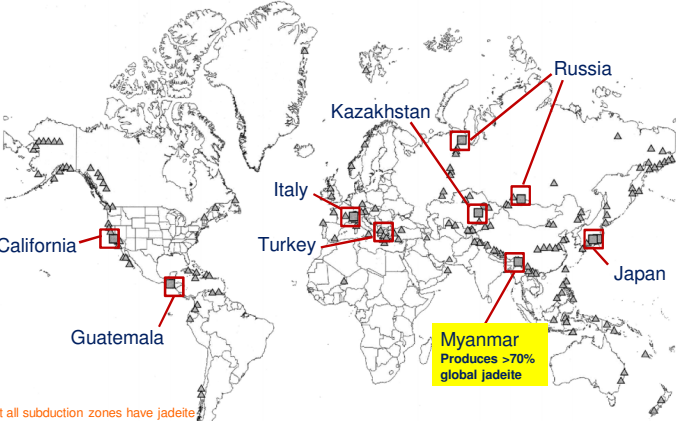
- Interaction of serpentinizing peridotite and **Na-Al-Si fluids** (from subducting slab) during active subduction
- Fluid flows to faulted peridotite (serpentine mélangé)
- Jadeite crystallizes in veins
- Preserve by diapiric rise of host serpentinite
 - The key is how the jadeite gets back to the surface



Schistose amphibolite inclusions

Harlow, G. E. & Sorensen S. S. 2005. Jade (Nephrite and Jadeite) and Serpentinite: Metasomatic Connections. International Geology Review, 47, p113-146.

Distribution of Jadeite



*Not all subduction zones have jadeite

▲ Blueschists
■ Jadeites

Harlow, G. E. & Sorensen S. S. 2005. Jade (Nephrite and Jadeite) and Serpentinite: Metasomatic Connections. International Geology Review, 47, p113-146.

Geology of Myanmar

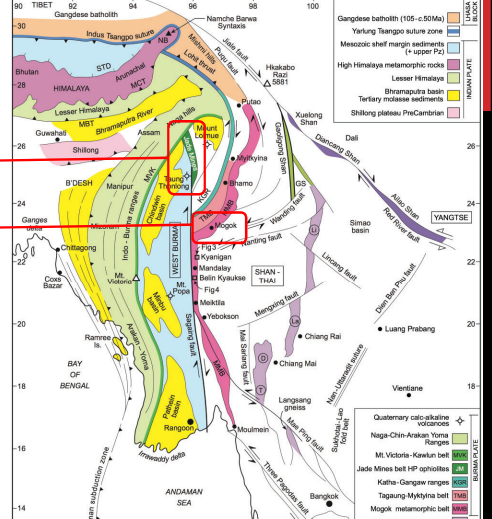
- Myanmar is located at a very active tectonic area: **Burma oblique subduction**, followed by **Sagaing strike-slip fault system**
- N-S oriented tectonic mélangé and metamorphic belts




Myanmar has an unique geological setting

Hpakon-Tawmaw Jade Tract: Jadeite-albite dykes and veins produce >70% global jadeite


Mogok Gemstone Tract: ruby and sapphire occur as primary minerals in marble, produce >90% global ruby



Gardiner N.J. et al. 2014. The metallogenic provinces of Myanmar. Applied Earth Science (Trans. Inst. Min. Metall. B), 123, p25-38.


“Outcrop”

- Landmark of ‘Jade Street’
- Monument of Burmese jadeite located at the intersection of Canton Road and Jordan Road



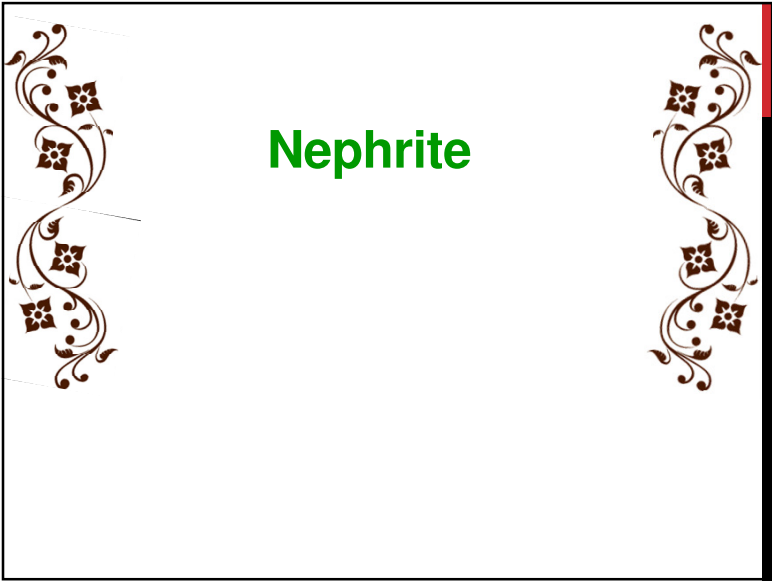
Varieties of Jadeite

- Purest form: Colourless
- Emerald green: Cr³⁺
- Leave green: Fe²⁺
- Bluish green: Fe²⁺ and Fe³⁺
- Yellowish green: Fe³⁺
- Mauve/Lavender: Mn³⁺
- Black: micro-inclusion of graphite




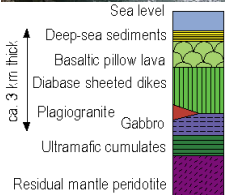
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[http://forum.purejadeite.com/attachments/accessories-yourself/the-jewelry-box/jewelry-reference-forum/261901641400273019-jade-and-jadeite-photos-on-michael-2-juveooooooooooooooooooooo-25798190.jpg](http://forum.purejadeite.com/attachments/accessories-yourself/the-jewelry-box/jewelry-reference-forum/261901641400273019-jade-and-jadeite-photos-on-michael-2-juveooooooooooooo-25798190.jpg)
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Nephrite



Geological Settings of Nephrite

- (1) Associated with ophiolite belts
 - Ophiolites are pieces of oceanic plate obducted onto the edge of continental plates
 - Consists of mafic and ultramafic rocks
 - Along suture zone and continental margin
- (2) Contact regions of dolomite and igneous dykes/plutons
 - High temperature and medium pressure condition
 - Greenschist to Amphibolite facies
 - No specific geological settings

Picture from:
http://earth.s.kanazawa-u.ac.jp/shweb/1fe_stra.GIF

Genesis (1) Serpentinite replacement by metasomatism with silicic rocks

- **Ca-rich** hydrous fluid interacts with **Mg-rich** serpentinite
- Nephrite does not occur in high temperature metamorphism region (~400°C)
- Post-igneous process
- Metasomatic zoning sequence
- Along fault, fractures, contacts and structural boundaries

Harlow, G. E. & Sorensen S. S. 2005. Jade (Nephrite and Jadeite) and Serpentinite: Metasomatic Connections. International Geology, Review, 47, p113-146.

Genesis (2) Dolomite replacement by silicic fluids with granitic plutons

- Magmatic fluids flow through dolomite
- Contact and/or infiltration metasomatism
- Nephrite is formed along fault and fissure
- Less abundant comparatively

$$5\text{Ca}(\text{Mg,Fe})(\text{CO}_3)_2 + 8\text{SiO}_2 + \text{H}_2\text{O} \rightarrow \text{Actinolite}$$

$$\text{Ca}_2(\text{Mg,Fe})_5\text{Si}_8\text{O}_{22}(\text{OH})_2 + 3\text{CaCO}_3 + 7\text{CO}_2$$

Harlow, G. E. & Sorensen S. S. 2005. Jade (Nephrite and Jadeite) and Serpentinite: Metasomatic Connections. International Geology, Review, 47, p113-146.

Distribution of Nephrite

Harlow, G. E. & Sorensen S. S. 2005. Jade (Nephrite and Jadeite) and Serpentinite: Metasomatic Connections. International Geology, Review, 47, p113-146.


Nephrite appreciation

- Hong Kong Museum of Art (Chinese antiques)
- Flagstaff House Museum of Tea Ware (Seals)
- Stephen Hui Geological Museum, HKU (Rock samples)

http://www.iced.gov.hk/CE/Museum/Arts/en_US/web/ma/collection01.html
http://www.earthsciences.hku.hk/hkmuseum/collection_min_12.php
http://www.iced.gov.hk/CE/Museum/Amp/en_US/web/ma/teaware05.html

Varieties of Nephrite

- Mutton-fat jade (羊脂白玉): Pure white
- Tomb jade: chalk-coloured
- Chicken bone jade: whitened
- White: Tremolite
- Green: Actinolite
- Black: Fe-actinolite or graphite inclusions



Pic from:
<http://img.51786.com/obj/121289/725648.jpg>
http://sitedirect.com/mex/buy/antique_chinese_tomb_bangle_bracelet_jade_celeston_or_p_jade_from_japan_collector_1_thumb2_low.jpg
http://www.hendeljade.com/1497/548102965161_1_1.jpg
<http://www.orientconcepts.com/shoppingcorner/upload/product/10505665.JPG>

Common fake jades

- New / Olive / Asian / Lemon / Suzhou Jade
- Serpentine
- Snow / White / Marble / Mountain Jade
- Quartz and Marble
- Indian / Regal Jade
- Green aventurine
- Amazon / Colorado / Virginia Jade
- Amazonite



Pic from:
<http://01.i.aliimg.com/wspphoto/0/2036486509/6mm-round-beads-Olive-New-Jade-fort-b-green-b-fort-fort-b-serpentine-b-fort.jpg>
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http://03.i.aliimg.com/wspphoto/0/1317012728_11/Free-shape-4mm-6mm-8mm-10mm-Natural-High-quality-charms-Green-fort-b-Aventurine-b-fort.jpg

China's 4 famous jades (中國四大名玉)

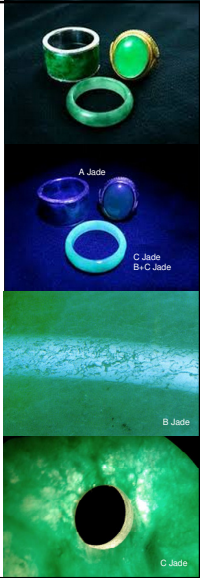
- Hetian jade from Xinjiang (和田玉): Nephrite
- Dushan jade from Henan (獨山玉): Pyroxene + Plagioclase
- Turquoise from Hubei (綠松石)
- Xiuyan jade from Liaoning (岫岩玉): Nephrite-Serpentine
 - Not all of them are Nephrites!
- Olympic medals 2008: Nephrite
 - Kunlun jade (崑崙玉) from Qinghai
 - Xinjiang Kunlun jade is Serpentine!



Pic from:
<http://00.sinajma.cn/travel/news/2008-09-19/3008P704T2026359F101D120080919114116.jpg>

Classes of Jadeite

- A Jade: Unprocessed, natural jade
 - Polished with wax
- B Jade: Artificially treated (bleaching)
 - Translucency enhanced
 - Impregnated with polymer
- C Jade: Colour altered (dyeing)
 - Florescent under UV light
- B+C Jade: Bleached and dyed
 - Florescent under UV light
- It does not represent the grade or the quality of jade!



Pic from:
<https://theadjournal.wordpress.com/tag/jade-b/>
<http://3.sinajma.com/mid/56172557a60914e952e2a680>
<http://www.shopgemstones.com/wp-content/uploads/2011/10/0vedjadette-cracks.jpg>

Appraising Jadeite

- 種 Texture/Type
 - Old mine (老坑種), New mine (新坑種), Ice (冰種)
- 色 Colour: evenness and intensity
 - Intense green with dark tone is more valued
- 透 Translucency
- 瑩 Refractivity
- 花 Impurity: amount of inclusion
- 大 Shape/Size
- 工 Craftsmanship
- 瑕 Cracks/Fractures
 - "Gold has a price but jade is priceless" 黃金有價玉無價
 - Difficult to evaluate the value

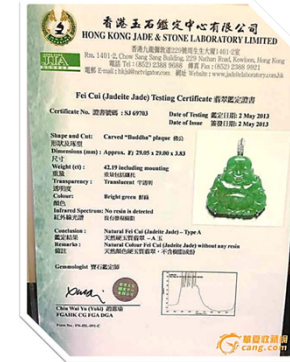


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http://www.omegawatches.com/uploads/resize/13115431401225c_d.jpg

How to identify real jades?

- Certificate of authenticity
 - It can tell the jade is natural or treated but never appraise the value
- B, C, B+C jade florescent under UV light
- Jadeite is heavier than other minerals
- Perform a density test:
 - Jadeite has a density of 3.30-3.36 g/cm³
 - Nephrite has a density of 2.98-3.03 g/cm³

$$\frac{\text{Mass of mineral (g)}}{\text{Volume of mineral (cm}^3\text{)}}$$



Pic from:
<http://img.diancang.com/201307/01/2013070122194834827233.jpg>

Concluding remarks

- Jadeite and Nephrite are both formed by metasomatic process associated with serpentinite
- Jadeite is rarer and more valuable than Nephrite
- Nephrite has a historical value in Chinese culture



References

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Q & A

Thank you!

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