

Ore Deposit Models & Exploration Course

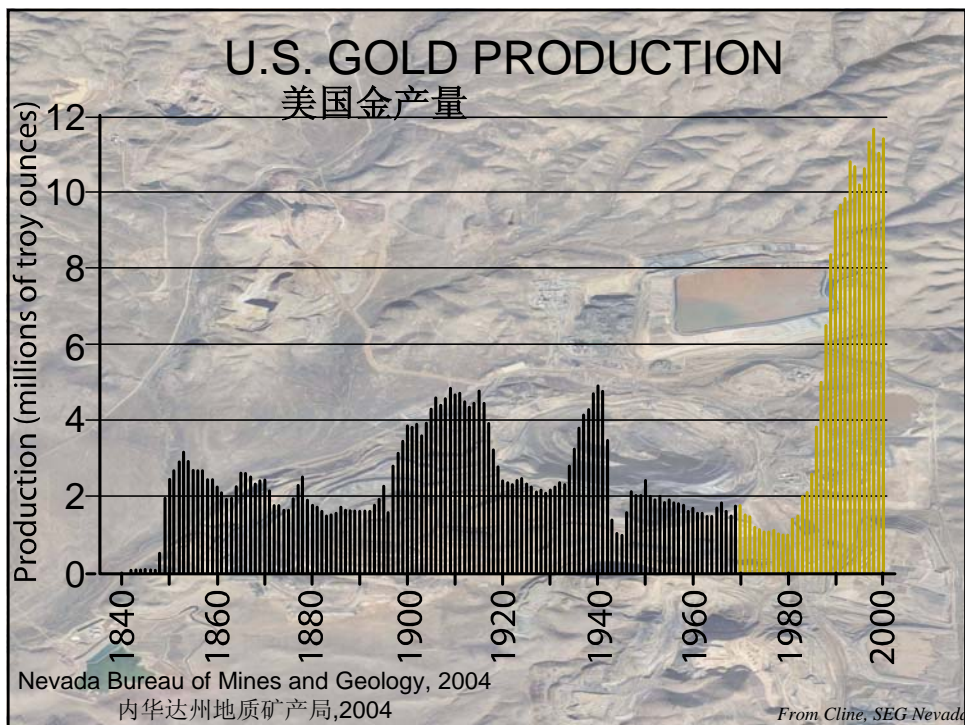
Carlin Type Gold Deposit

卡林型金矿

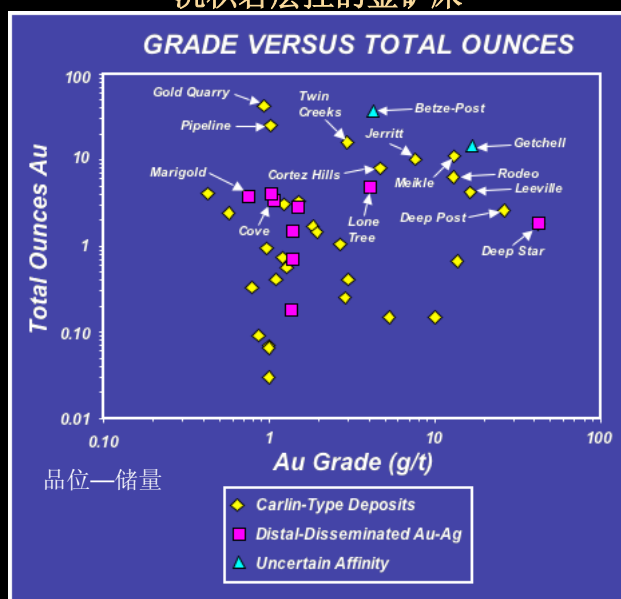
Richard J. Goldfarb

Ore Deposit Models & Exploration Course
Kunming, China—November 1-5, 2008

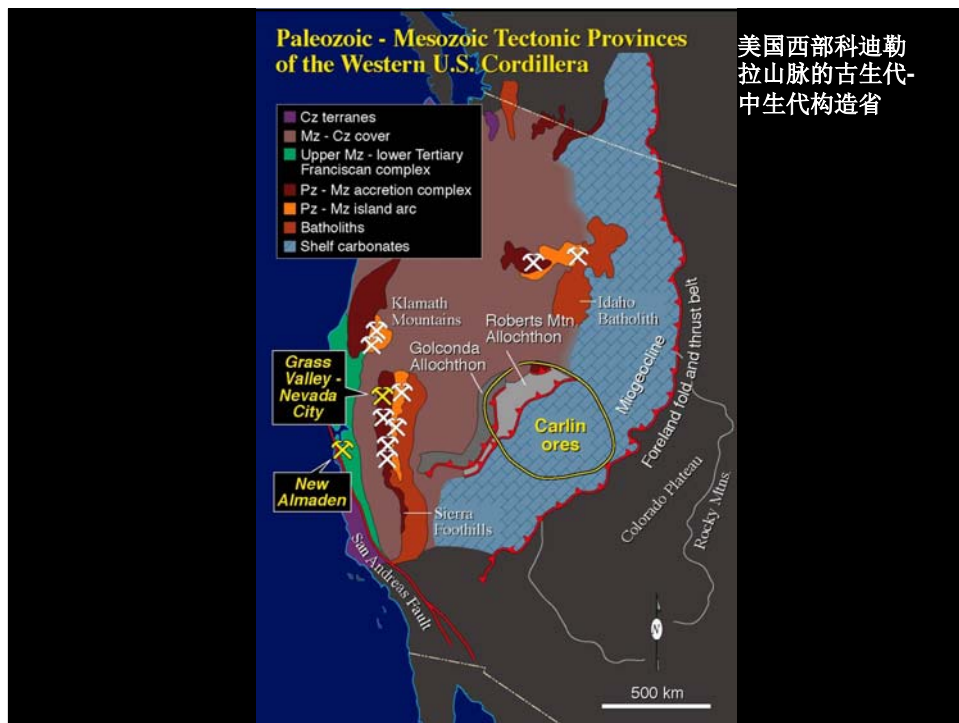




SEDIMENTARY ROCK-HOSTED GOLD DEPOSITS 沉积岩层控的金矿床

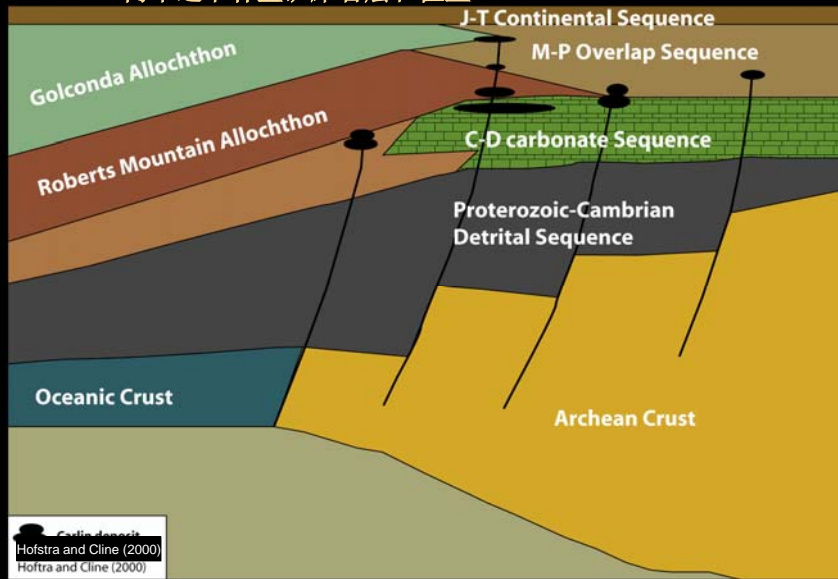


From Johnston, SEG Nevada



Nevada Stratigraphy and Location of Carlin Ores

内华达卡林型矿床岩层和位置

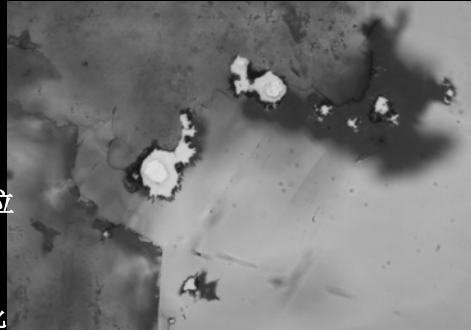


From Johnston, SFG Nevada

CTGD - What we know

CTGD-我们所知道的

- **large, epigenetic, sediment-hosted, disseminated Au**
巨大的,表生,沉积岩层控,浸染状Au矿
- **silty, pyritic, carbonaceous, calcareous host rock**
具黄铁矿化的粉砂质含碳钙质围岩
- **submicron Au in pyrite**
黄铁矿中赋存亚微细粒Au
- **low to high grade** 低到高品位
- **alteration: 蚀变类型**
 - **Decarbonization** 脱碳酸盐化
 - **argillization, silicification** 泥化,硅化
- **occur in trends and districts** 产出地带和区域



From Cline, SEG Nevada

Age of Deposits

矿床年龄

Galkhaite: $(\text{Cs}, \text{Tl})(\text{Hg}, \text{Cu}, \text{Zn})_6(\text{As}, \text{Sb})_4\text{S}_{12}$

硫砷铊汞矿

~50 wt% Hg	20 wt% S
15 wt% As	trace Au
200-300 ppm Rb	trace Sr

39.0 + 2.1 Ma
(Rb-Sr)

Tretbar et al., 1999



Photo from Dave Tretbar

**We can now relate the deposits to their
tectonic & structural setting**

我们现在可以将矿床与构造和结构环境联系起来

From Cline, SEG Nevada

UNLV

CTGD – Models

CTGD-模型

0.006 oz/t 1.42 oz/t

Crystallizing magma produced heat \pm hydrothermal fluids \pm metals (Sillitoe & Bonham, 1990; Henry & Ressel, 2000; Johnston & Ressel, 2004)

正在结晶的岩浆产生热量 \pm 热液流体 \pm 金属 (Sillitoe 和 Bonham, 1990; Henry 和 Ressel, 2000; Johnston 和 Ressel, 2004)

Deeply circulating meteoric fluids leached and remobilized metals (Ilchik & Barton, 1997; Emsbo et al., 2003) 进入深部循环的大气降水淋滤并活化了金属 (Ilchik 和 Barton, 1997; Emsbo et al., 2003)

Metamorphism produced ore fluids that transported metals (Seedorff, 1991; Hofstra & Cline, 2000) 变质作用产生成矿流体，携带金属运移 (Seedorff, 1991; Hofstra 和 Cline, 2000)

Model Must Address:

模型必须关注

- H isotopes indicate deep waters at some deposits and meteoric waters at other deposits
H同位素表明一些矿床的水来自深部，而另一些则来自大气降水
- S isotopes indicate sedimentary S at most deposits, but magmatic S is permissive at some deposits
S同位素指示着多数矿床的S来自沉积物，但一些矿床中S则来自岩浆
- Ore fluid temperatures are low - 180-240° C, and have low salinities - 2-3 wt% NaCl equiv
矿石流体是低温 (180-240° C), 低盐度的 (2-3 wt% NaCl 当量)
- Lack of strong elemental / alteration zoning
缺乏明显的元素/蚀变分带
- No spatial association with coeval hypabyssal stocks
与同时代浅成岩株没有空间伴生关系

Primer 入门

Carlin-type deposits in NV: 内华达的卡林型矿床:

Carlin, Getchell & BME trends,
Jerritt Canyon, Alligator Ridge districts

Distal disseminated deposits (DDD, Cox & Singer, 1990, 1992): 细脉浸染型矿床 (DDD型):

Au deposits spatially and genetically related to porphyry systems 金矿在空间和起源上都与斑岩系统相关
(Star Pointer, Smith et al., 1988; Barney's Canyon, Cunningham et al., 2004)

Camp 1: NV Carlin-type deposits are DDD

Camp?1 : NV 卡林型矿床属DDD型

Camp 2: NV Carlin-type deposits are not DDD

Camp2 : NV 卡林型矿床不属于DDD型

Carlin like deposits (Seedorff, 1991) 类卡林型矿床

Essentially like DDD 实质上很象DDD型

UNLV

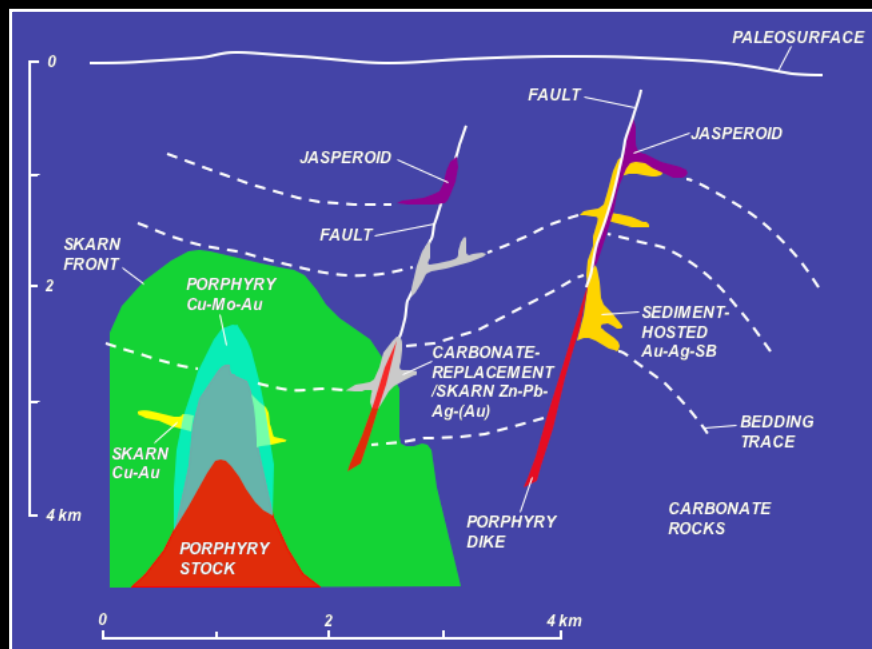
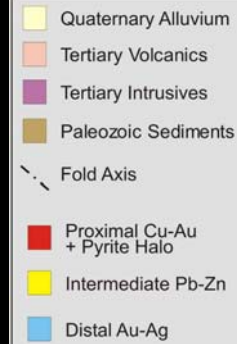
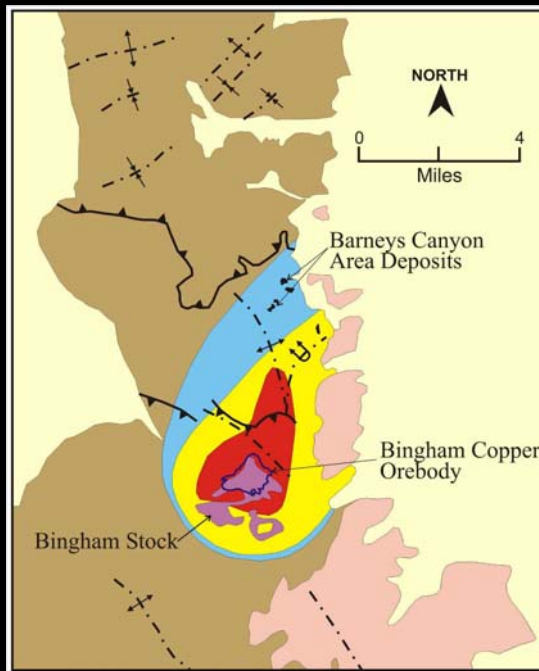


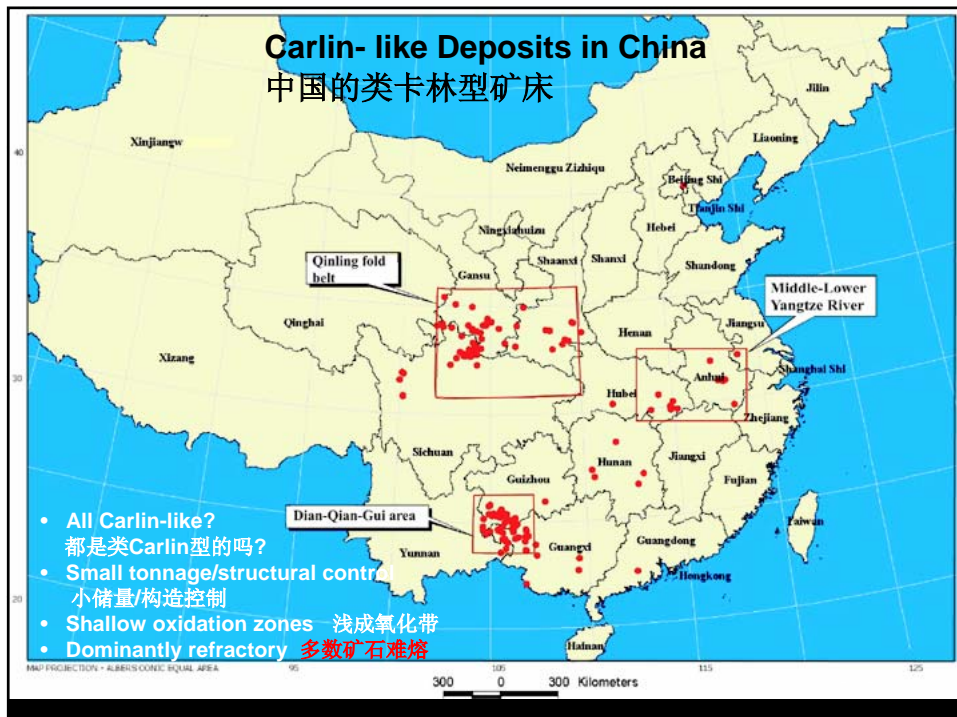
FIGURE ADAPTED FROM SILLITOE AND BONHAM (1990)

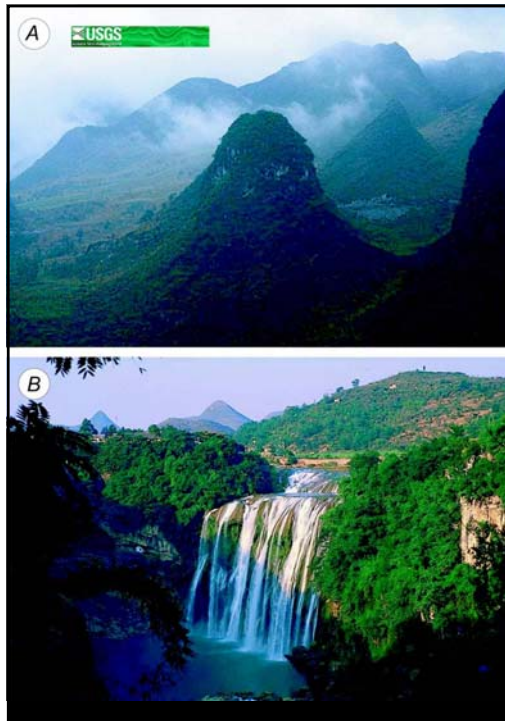
SILLITOE AND BONHAM (1990) 地质剖面图



Metal and deposit zonation around the 39 Ma Bingham stock (modified from Gunter and Austin, 1997)

39 Ma Bingham 岩株周围的金属和矿床分带(据Gunter 和 Austin, 1997修订)

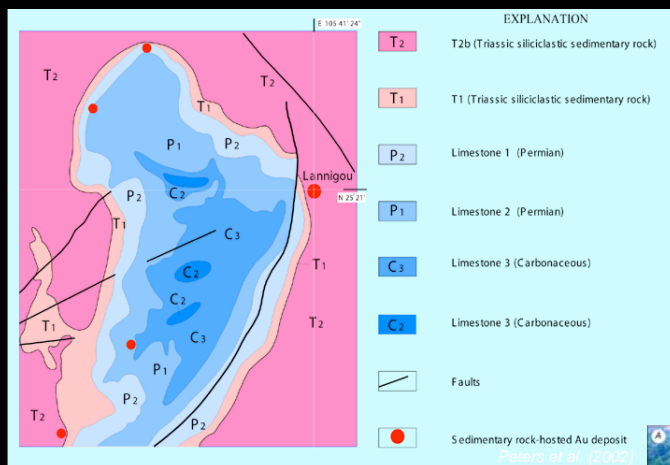




Dian-Qian-Gui Province 滇黔桂地区

- **Mountains and high plateaus** 山脉和高原
- **1000-2000 m elevation** 海拔1000-2000m
- **Karst (Permo-Triassic-plateau)** 喀斯特(二叠纪-三叠纪高原)

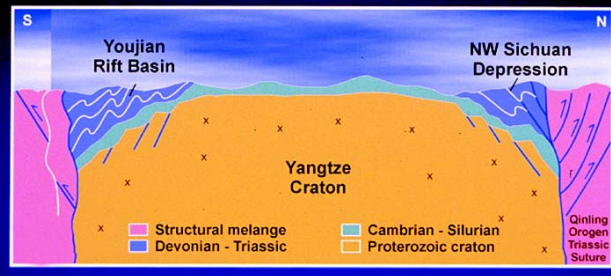
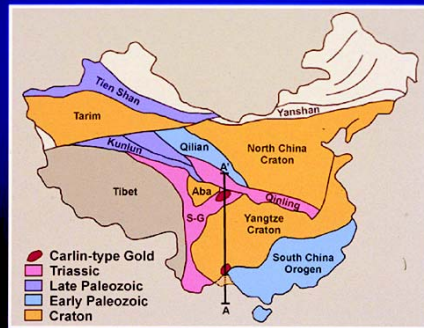
LANNIGOU DEPOSIT 烂泥沟矿床



- **Anticlinal Dome** 背斜穹隆(80t, 7 g/t)
- **Gold in steep faults (not shown) on edge of dome**
金矿产出于穹窿边缘的陡立断层中(未展示)



Carlin deposits - W. Yangtze Craton 卡林型矿床-扬子 克拉通西部



- Triassic or younger 三叠纪或更早
- As-Au-Hg-Sb-Tl
- Transition zone: carbonate and siliceous clastics

Hofstra and
Christensen
(2002)

Mineralization Styles in Dian-Qian-Gui Deposits

滇黔桂矿床的矿化类型

Getang Deposit

戈塘矿床



Unconformity-hosted ore (Rain-like)

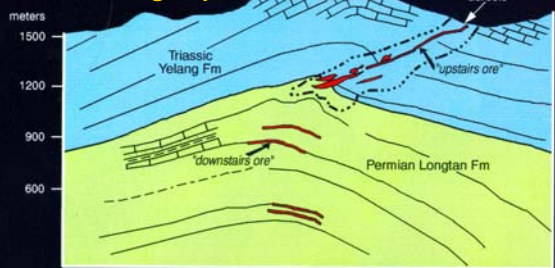
不整合面控矿

Banqi Deposit

板其矿床



Zimoudang Deposit



Fault-controlled ore

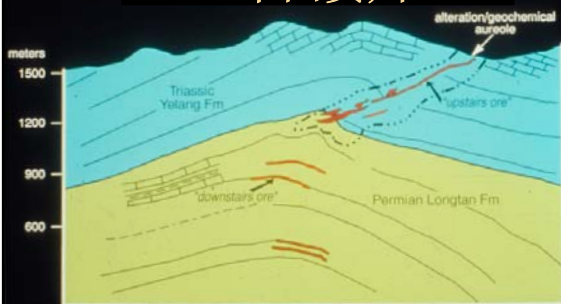
断层控矿

Stratabound ore

地层控矿

ZIMOUDANG GOLD DEPOSIT GUIZHOU, CHINA

中国贵州ZIMOUDANG金矿



- 60t Au, 5.0 g/t
- mining oxide (heap-leach)
开采氧化矿(堆浸)
- breccia zone along thrust
沿逆冲断层的角砾岩带
- hypogene ore stockpile
深部聚集成矿



CROSS SECTION OF GETANG GOLD DEPOSIT GUIZHOU CHINA

中国贵州戈塘金矿横截面



- 22t Au, 6.2g/t; 10+ ore
bodies矿体
- silicified and brecciated
argillite and limestone
along unconformity in
Perm rocks
沿二叠纪岩石不整合面而硅酸盐化和
角砾岩化的粘土岩和灰岩



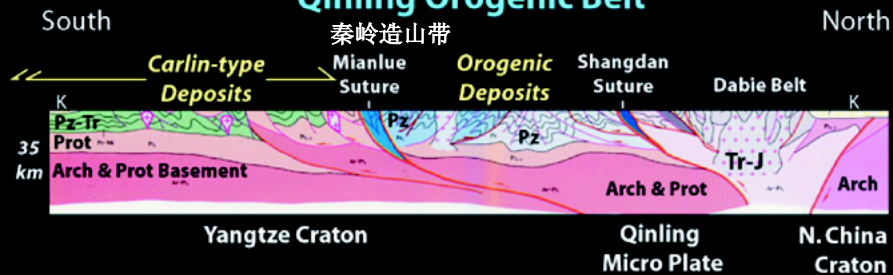
Western Qinling Gold Belt

西秦岭金成矿带



- | | | |
|-----------------------------|---------------------------------------|--------------------|
| ■ Basement (p €) | ■ Platform rocks (L Prot to E Tr) | ◆ Orogenic gold |
| ■ Volcanic arc (E Pz) | ■ Songpan-Ganzi turbidites (M - L Tr) | ■ Carlin-like gold |
| ■ Slate and graywacke (Dev) | ■ Granitoid (Tr - J) | ▲ Skarn gold |
| | | ★ Gold placer |

Qinling Orogenic Belt



早三叠纪
三叠纪-侏罗纪
晚侏罗-白垩纪
第三纪

Early Triassic
Triassic-Jurassic
L. Jur-Cret
Tertiary

Collision of Yangtze and Qinling/N. China Cratons
Post-Collisional Magmatism & Contraction
Uplift & Extension
Collision of India, Transpression

中国扬子板块与西秦岭板块的碰撞
后期碰撞引起的岩浆作用与收缩作用
抬升与扩张
印度板块的碰撞, 压剪作用

Hofstra and Christensen (2002)

Differences from Orogenic Giants

与造山带巨型矿床的不同



- **Broader range in H-O**
H-O间更宽的范围
- **Lower CO₂** 更低含量的CO₂
- **Common Tl, F, Ba**
正常的Tl, F, Ba 含量
- **Limited vertical extent**
有限的垂向延深
- **Refractory nature of ores?**
矿石的难熔性?
- **Widespread carbonate dissolution and argillization?**
广泛分布的碳酸盐熔蚀和泥化
- **Location?** 产出位置?