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## 阿尔金造山带青白口纪片麻状花岗岩的厘定及对 Rodinia超大陆汇聚时限的制约

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提要:阿尔金造山带新元古代花岗岩的研究对探讨该地区Rodinia超大陆汇聚阶段构造演化过程具有重要意义。本 文对在亚干布阳一带新厘定的青白口纪片麻状花岗岩开展了详细的岩石学、年代学和岩石地球化学研究。锆石LA -ICP-MS U-Pb年代学证据显示片麻状花岗岩结晶年龄分别为(883.0±3.3)Ma和(883.1±3.3)Ma,说明其侵位于青白 口纪。地球化学结果显示,常量元素具有富硅、铝、钾和低钠、镁、钙和钛的特点,具钙碱性-高钾钙碱性、过铝质花岗 岩特征。岩石轻稀土分馏较强而重稀土分馏较弱,具有明显的负Eu异常,总体呈右倾的"V"型稀土分配模式。岩石 富集Rb、Th、LREE等大离子亲石元素,中等亏损Ba,强烈亏损Nb、Sr、P、Hf、Ti等高场强元素,总体特征显示了典型 的壳源花岗岩的特征,其源于地壳变质砂岩部分熔融,形成于同碰撞晚期构造环境,属Rodinia超大陆汇聚阶段的产 物。综合研究表明,阿尔金地区新元古代早期同碰撞型岩体的形成时代集中在871~945 Ma,限定了Rodinia超大陆 汇聚时限,且在空间上构成了一条重要的岩浆岩带,是对Rodinia超大陆碰撞汇聚作用的响应。

**关 键 词:**片麻状花岗岩;LA-ICP-MS 锆石 U-Pb 定年;地球化学;构造环境;Rodinia 超大陆;地质调查工程;阿尔金 中国分类号:P588.12<sup>+</sup>1; P597; P595 文献标志码:A 文章编号:1000-3657(2020)03-0569-21

# Confirmation of gneissic granite of Qingbaikou period and its constraint on the timing of the Rodinia supercontinent on the Altun orogenic belt

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Abstract: The study of the Neoproterozoic granites in the Altun orogenic belt is significant for revealing the area of the Rodinia

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supercontinent convergent stage tectonic evolution. In this paper, a detailed study of petrology, chronology and geochemistry was carried out for a new division of Qingbaikou gneissic granite in Yaganbuyang area. The U–Pb dating of zircons from the gneissic granite using LA– ICP– MS yielded ( $883.0 \pm 3.3$ )Ma and ( $883.1 \pm 3.3$ )Ma, indicating that the gneissic granite was generated in Qingbaikou period. The geochemical analysis shows that major elements are characterized by high SiO<sub>2</sub>, Al<sub>2</sub>O<sub>3</sub> and K<sub>2</sub>O values and low Na<sub>2</sub>O, MgO, CaO and TiO<sub>2</sub> values, thus belonging to the calc–alkaline– high–K calc–alkaline series, and peraluminous.REE distribution patterns show negative anomaly of Eu, obvious fractionation of LREE and weak fractionation of HREE, with a clear V trough, which shows the features of crustal derived granite. The gneissic granite is rich in large ion lithophile elements of Rb, Th, LREE, slightly depleted in Ba and mightily depleted in high field strength elements of Nb, Sr, P, Hf, Ti. These characteristics are similar to features of the continental collision type granite. The source rock of the gneissic granite was formed by the partial melting metasandstone from the crust in the subduction–collisional environment about Rodinia supercontinent. Comprehensive study shows that these syn– collisional granites were generated between 871 Ma and 940 Ma, which constrained the timing of the Rodinia supercontinent in Early Neoproterozoic along the Altun orogenic belt. These rock bodies have the characteristics of zonal distribution in space and confirm the existence of syn–collisional granites belt about Rodinia supercontinent on the Altun orogenic belt.

Key words: gneissic granite; LA-ICP-MS zircon U-Pb dating; geochemistry; construction environment; Rodinia supercontinent; geological survey engineering; Altun

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## 1 引 言

阿尔金造山带地处青藏高原北缘,位于塔里木 地块和柴达木地块之间,是一个早期经历古板块或 地块相互俯冲一碰撞作用,在中、新生代又被走滑 断裂所切断,由不同构造层次、不同时期和形成于 不同构造环境地质体所组成的复合造山带(车自成 等,1995;刘良等,1996;崔军文等,1999;许志琴等, 1999;Zhang et al.,1999)。阿尔金造山带也一直是 地质学家研究的热点,大量研究围绕早古生代高 压一超高压变质岩、古生代花岗岩和前寒武纪构造 演化方面开展。

在高压一超高压变质岩方面,研究表明沿阿尔 金构造带南缘断续存在一条早古生代的高压一超 高压变质岩带,并确定这些高压一超高压岩石的原 岩的形成时代多为719~1000 Ma,变质时代介于 486~509 Ma,退变质时代为~450 Ma(Zhang et al., 2001;刘良等,2007;张建新等,2007;曹玉亭等, 2009;Wang et al., 2011)。

在古生代花岗岩研究方面,不同研究者对鱼目 泉花岗质岩体、塔特勒克布拉克复式花岗岩体、茫 崖镇北石英闪长岩和阿卡龙山花岗岩、玉苏普阿勒 克塔格岩体、茫崖镇东柴水沟花岗岩、常春沟花岗 岩和帕夏拉依档岩体等早古生代花岗岩的形成时 代、岩石成因和构造环境进行了详细研究(曹玉亭 等,2010;康磊等,2013,2016;Wang et al.,2014;董 洪凯等,2014;吴才来等,2014;张若愚等,2016, 2018),这些后碰撞型花岗岩形成时代介于(446±3)~ (469.3±5.7)Ma,形成于俯冲碰撞造山后抬升阶段。 可能是~450 Ma的陆壳深俯冲/折返事件的岩浆 响应。

阿尔金及邻区前寒武纪构造格架研究也受到 众多学者的关注。在阿尔金地区,刘永顺等(2009) 识别出多期前寒武重要地质事件:2.5~3.6 Ga敦煌 地块内存在太古宙古老地壳和多期的岩浆活动, 1.8~2.5 Ga敦煌地块遭受强烈改造和中基性侵入岩 形成的时代,0.8~1.0 Ga存在新元古代碰撞造山和 大规模的岩浆活动,500~530 Ma是阿尔金北缘蛇绿 混杂岩带、高压变质泥质岩和榴辉岩的变质时代; 张建新等(2011)认为新元古代早期(920~940 Ma) 的构造热事件与 Rodinia 超大陆汇聚相关,新元古 代晚期(760 Ma左右)与 Rodinia 超大陆裂解作用有

关,它们普遍遭受了早古生代变质作用的改造。在 阿尔金北部敦煌地区,前寒武纪研究的重大进展是 提出了敦煌造山带的概念,其前寒武纪结晶基底最 初拼合事件可能发生在新太古代末期(~2.5 Ga),之 后经历了古元古代晚期(1.8~2.0 Ga Ma)汇聚、碰撞 造山过程,该过程与Columbia超大陆汇聚有关,直 到中元古代早期(1.6~1.8 Ga)造山活动结束,前寒 武纪结晶基底最终固结,进入稳定发展阶段,直至 古生代志留纪开始活化(~440 Ma)(Zhao et al., 2015,2016; 王永等, 2017)。在阿尔金邻区塔里盆 地周缘,古元古代中期(2.13~2.15 Ga)为造山作用 的早期俯冲阶段,古元古代晚期(1.93~2.05 Ga)为 同碰撞造山阶段的响应;古元古代末期(1.85~1.87 Ga)进入后造山阶段(辛后田等,2011),古元古代(~ 1.8 Ga)之后塔里木接受了中元古代被动大陆边缘 沉积建造,直到~1.0 Ga开始转化为活动大陆边缘, 目 0.76~1.0 Ga 期间一首处于活动大陆边缘,经历了 中一新元古代与 Rodinia 超大陆聚合相关的造山事 件,并最终形成了塔里木前寒武纪基底(Lu et al., 2008;张建新等,2011)。由此可见,阿尔金及邻区 前寒武纪存在Columbia和Rodinia超大陆汇聚-裂 解事件,并与全球和中国大陆演化历史基本同步, 这一认识已被多数学者认可,但是 Columbia 和 Rodinia 超大陆汇聚-裂解具体时限还存在很大争 议,对阿尔金及邻区各地块的构造属性及其与华北 克拉通和扬子克拉通的亲缘性也存在较大的分歧。

近年来,阿尔金及其邻区与Rodinia超大陆汇聚 有关的岩浆响应被相继报道。在阿尔金江尕勒萨 依、清水泉、肖鲁克布拉克、亚干布阳、盖里克、科克 萨依等地区发育大量同碰撞型花岗质片麻岩,年龄 集中在871~945 Ma(Gehrels et al.,2003;王超等, 2006;校培喜等,2014;王立社等,2015;李琦等, 2015,2018;陈红杰等,2018)。在柴达木北缘鱼卡 河、沙柳河、锡铁山和落凤坡等地区发育与新元古 代早期汇聚有关的花岗质片麻岩带,年龄集中在 917~952 Ma(陆松年等,2002;张建新等,2003;王惠 初等,2004;林慈銮等,2006)。在祁连造山带结晶 基底中发育新元古代早期具有同碰撞性质的花岗 质岩浆岩,年龄集中在917~943 Ma(郭进京等, 1999;万渝生等,2003;董国安等,2007)。在秦岭造 山带也发育广泛与新元古代早期洋壳俯冲、陆块汇 聚地质事件相关的同构造花岗岩,东起西峡寨根, 西至武山李家沟,年龄集中在911~978 Ma(陆松年 等,2004;王涛等,2005;裴先治等,2007)。这些构 造热事件与塔里木(或晋宁)造山作用有关,它普遍 存在于阿尔金及其周缘的变质基底岩石中,与 Rodinia 超级大陆汇聚相关,也正是这次构造事件造 成了塔里木变质基底最终固结(Lu et al., 2008)。这 些新元古代同碰撞性质花岗岩的报道和研究,对于 探讨区内新元古代早期造山作用和西部古大陆构 造演化和各地块属性具有十分重要的意义。

笔者在主持新疆阿尔金地区1:5万 J45E010020 等6幅区调过程中,将前人1:25万苏吾什杰幅区调 所划分的新太古一古元古代亚干布阳片麻岩和盖 里克片麻岩时代重新厘定为新元古代青白口纪,认 为其为Rodinia超大陆汇聚阶段的产物,同时还在其 围岩古元古代阿尔金岩群中新解体出一套青白口 纪片麻状花岗岩,并在亚干布阳片麻岩和盖里克片 麻岩中分别获得了(900.2±2.9)Ma和(886.5±5)Ma同 位素测年数据(李琦等,2015,2018),而对新发现的 青白口纪片麻状花岗岩构造属性缺乏系统的研 究。因此,本文在详实的野外地质调查的基础上, 从岩石学、年代学、地球化学等方面对该花岗岩进 行研究,探讨了其岩石成因和构造背景,为阿尔金 造山带新元古代Rodinia超大陆汇聚阶段构造演化 提供了新证据。

## 2 区域地质背景及岩石学特征

#### 2.1 区域地质背景

根据阿尔金造山带地质背景研究最新成果,阿 尔金造山带自北向南可划分为红柳沟一拉配泉(蛇 绿)构造混杂岩带、阿中地块、阿南(蛇绿)构造混杂 岩带等3个构造单元(校培喜等,2014)(图1a)。本 文研究区位于阿尔金造山带南缘,以阿尔金南缘主 断裂为界,北部属阿中地块,南部属阿南(蛇绿)构 造混杂岩带(图1b)。

阿中地块出露地层主要有古元古代阿尔金岩 群、长城系巴什库尔干岩群红柳泉组、青白口系索 尔库里群冰沟南组和平洼沟组,岩浆活动主要集中 在青白口纪和中一晚奥陶世,青白口纪亚干布阳片 麻岩、盖里克片麻岩和本文重点研究的片麻状花岗 岩,均显示同碰撞构造环境特征,形成于Rodinia 超



TRB—塔里木盆地;QL—祁连山;QDB—柴达木盆地;WKL—西昆仑;EKL—东昆仑;HMLY—喜马拉雅山;INP—印度板块;Q—第四系; N<sub>2</sub>y—新近系油砂山组;J<sub>12</sub>dm—侏罗系大煤沟组;€OM<sup>®</sup>—奥陶纪茫崖蛇绿混杂岩;QbS—青白口系索尔库里群;Pt<sub>4</sub>A—古元古代阿尔金岩群; O—S玉苏普阿勒塔格岩体;O<sub>23</sub>—帕夏拉依档岩体;vQb—斜长角闪岩;yQb—片麻状花岗岩;y∂Qb—盖里克片麻岩;y∂oQb—亚干布阳片麻岩; OΣH—超基性岩块体;β—玄武岩块体;v—辉长岩脉



TRB-Traim Basin; QL-Qilian Mountains; QDB-Qaidam Basin; WKL-Western Kunlun Mountains; EKL-Eastern Kunlun Mountains; HMLY-Himalaya Mountains; INP-Indian Plate; Q-Quaternary; N<sub>2</sub>y-Neogene Youshashan Formation; J<sub>1-2</sub>dm-Jurassic Dameigou Formation; COMm – Ordovician Mengya ophiolite melange; QbS-Qingbaikou System Suorkuli Group; Pt<sub>1</sub>A-Palaeoproterozoic Altun rock group;O-S-Yusupualeke Tagh plutons; O<sub>2-3</sub>-Paxialayidang plutons; vQb-Amphibolite; γQb-gneissic granite; γδQb-Gailike plutons; γδoQb – Yaganbuyang syenogranite; OΣH-Ultrabasic rock block; β-Bsaltic Block; ν-Gabbro dyke

大陆的汇聚阶段。青白口纪斜长角闪岩((857.4± 7.1)Ma),具有板内初始裂谷环境的地球化学特征, 形成于 Rodinia 初始裂解阶段(毕政家等,2016)。 中一晚奧陶世帕夏拉依档岩体,从早到晚可进一步 划分二长花岗岩((460.1±3.9)Ma)(张若愚等,2016)、 偶含斑黑云二长花岗岩和正长花岗岩((455.1±3.6) Ma)(张若愚等,2018)等三个侵入体,形成于同碰撞 挤压体制向后碰撞拉张转换的构造环境。

阿南(蛇绿)构造混杂岩带主要由蛇绿岩块体、 蛇绿岩上覆岩系块体、外来块体和基质组成,下— 中侏罗统陆相大煤沟组和中新统滨浅湖相-扇三角 洲相油砂山组均上覆于蛇绿构造混杂岩带之上,岩 浆活动可划分为青白口纪、寒武纪—早奧陶世和晚 奧陶—早志留世3期,其中以晚奧陶—早志留世玉 苏普阿勒克塔格岩体最为发育。关于其中蛇绿岩 的形成时代,刘良等(1998)测得茫崖地区玄武岩全 岩 Sm-Nd等时线年龄为(481.3±53)Ma;李向民等 (2009)获得约马克其辉长岩的锆石 U-Pb 年龄为 (500.7±1.9)Ma;郭金城等(2014)测得长沙沟地区辉 石橄榄岩的锆石 U-Pb 年龄为(510.6±1.4)Ma。这 些蛇绿岩均具有 E-MORB 或N-MORB 的地球化 学特征,形成于洋中脊构造环境,这些证据表明寒 武纪中期—早奥陶世研究区存在大洋中脊扩张。

#### 2.2 岩石学特征

青白口纪片麻状花岗岩是从阿尔金岩群中解 体出来的,位于研究区西北部亚干布阳一带,长约 7 km, 宽约3 km, 出露面积约20 km<sup>2</sup>, 呈椭圆形, 近 东西向展布,展布方向与区域构造线方向基本一 致。该侵入体与阿尔金岩群为侵入接触关系,内 部可见阿尔金岩群捕掳体,与亚干布阳片麻岩呈 脉动接触关系,二者片麻理产状方向基本一致。 结合亚干布阳片麻岩、盖里克片麻岩变质特征,该 期变质侵入体出现的典型变质矿物为黑云母、角 闪石、石榴子石、绿帘石等,矿物结晶粒度较为粗 大(0.2~0.5 mm),变质矿物中包裹体也较少,显示 矿物结晶程度比较高,此外其黑云母多呈红褐一 浅褐色,角闪石多褐绿色,这些变质特征表明变质 侵入体变质岩系为低角闪岩相,中温中压变质条 件,属石榴子石带、电气石带,变质作用类型为区 域动力热流变质作用。根据野外观察和薄片鉴定 结果,其岩性以片麻状黑云母花岗岩为主,还可见 少量片麻状黑云母正长花岗岩和片麻状二云正长花岗岩(图2a, b)。

片麻状黑云母花岗岩:具花岗结构、文象结构,弱片麻状构造、块状构造。主要由微斜长石 (40%)、条纹长石(5%)、斜长石(20%)、石英 (25%)、黑云母(7%)和白云母(3%)组成。微斜长 石呈他形粒状,具格子双晶,晶体表面比较干净, 包裹有石英细小晶体,边部有文象交生结构,杂乱 分布。条纹长石呈他形粒状,具细脉状条纹,为正 条纹长石。斜长石呈半自形板状,具细密的聚片 双晶、机械双晶,为更长石,杂乱分布。石英呈他 形粒状、不规则状,晶体表面较干净,显微裂纹比 较发育,集晶形成团块或透镜体。黑云母呈半自 形片状,一组解理发育,断续定向排列。白云母呈 片状,断续定向排列(图2c)。

片麻状黑云正长花岗岩:具花岗结构,弱片麻 状构造、块状构造。主要由钾长石(40%~45%)、斜 长石(5%~7%)、石英(25%~30%)、黑云母(12%~ 15%)、白云母(4%~6%)和少量铁质组成。钾长石 主要是微斜长石,多呈他形粒状,粒径0.1~2.3 mm, 表面较干净或弱黏土化,格子双晶发育,部分内部 可见有石英、云母等矿物的包体或嵌晶;斜长石呈 半自形柱状至他形粒状,粒径0.1~0.8 mm,表面浑 浊发生黏土化和绢云母化,多发育聚片双晶或卡钠 复合双晶;石英呈不规则粒状,粒径0.05~2.5 mm, 表面干净,波状消光,多包含或边缘嵌入长石或云 母等矿物呈包含嵌晶结构;黑云母多呈半自形板片 状或长条片状,半定向分布,大小0.1~1.6 mm;白云 母多呈半自形板片状或长条片状,半定向分布,大 小0.1~1.5 mm;铁质呈半自形至他形粒状,黑色不 透明,零星分布(图2d)。

片麻状二云正长花岗岩:具花岗结构,弱片麻 状构造、块状构造。主要由钾长石(40%~45%)、斜 长石(8%~10%)、石英(25%~30%)、黑云母(8%~ 10%)、白云母(5%~8%)和少量铁质(1%±)组成。钾 长石主要是微斜长石,多呈他形粒状,粒径0.1~1.2 mm,多发育格子双晶,部分内部可见有石英、云母 等矿物的包体或嵌晶;斜长石呈半自形柱状至他形 粒状,粒径0.1~0.7 mm,多发育聚片双晶或卡钠复 合双晶;石英呈不规则粒状,粒径0.05~1.1 mm,部 分包含或边缘嵌入长石或云母等矿物呈包含嵌晶

质



图 2 片麻状花岗岩野外宏观特征及显微镜下照片 a、b一片麻状黑云花岗岩宏观露头照片;c、d一片麻状黑云母花岗岩显微照片(c-PM004/6-1Bb,正交偏光;d-PM003/4-1Bb, 正交偏光);PI一斜长石;Mi一微斜长石;Q一石英;Bit-黑云母;Mu一白云母;Hb-角闪石 Fig.2 The outcrop and microstructure photos of gneissic granite A, b-The outcrop photos of gneissoid-biotitic granite; c-Micro-photos of gneissoid-biotitic granite (PM004/6-1Bb, crossed nicols-PM003/4-1Bb,

A, b-The outcrop photos of gneissoid-biotitic granite; c-Micro-photos of gneissoid-biotitic granite (PM004/6-1Bb, crossed nicols-PM003/4-1Bb crossed nicols) ; Pl-Plagioclase; Mi-Microline; Q-Quartz; Bit-Biotite; Mu-Muscovite; Hb-Hornblende

结构;黑云母多呈半自形板片状或长条片状,不连续定向分布,大小0.05~0.7 mm;白云母多呈半自形板片状或长条片状,不连续定向分布,大小0.05~0.5 mm;铁质呈自形、半自形至他形粒状,零星分布。

## 3 分析方法

## 3.1 锆石U-Pb同位素定年

在片麻状黑云母花岗岩中采集锆石U-Pb定年 样品2件,样品编号分别为PM003-4和PM004-6, 采样点坐标分别为:38°19′02″N,89°45′23″E,H 3880 m;38°27′43″N,89°21′40″E,H 3460 m。采集样 品约15 kg,在核工业二〇三研究所采用常规方法进 行粉碎,并用浮选和电磁选方法进行分选,然后在 双目镜下挑选出晶形和透明度较好的锆石颗粒,将 它们黏贴在环氧树脂表面,待环氧树脂充分固化 后,再对其进行抛光至锆石内部暴露。在西北大学 大陆动力学国家重点实验室进行反射光、透射光和 阴极发光显微照相,锆石的CL图像分析在装有英 国Gatan公司生产的Mono CL3+阴极发光装置系统 的电子显微扫描电镜上完成。通过对反射光、透射 光和阴极发光图像分析,选择吸收程度均匀和形态 明显不同的区域进行分析。

锆石微量元素含量和U-Pb同位素定年在西北 大学大陆动力学国家重点实验室的LA-ICP-MS仪 器上用标准测定程序进行。分析仪器为美国 Agilent公司生产的Agilent7500a型四极杆质谱仪和 德国 Microlas公司生产的Geolas200M型激光剥蚀 系统,激光器为193 nm 深紫外ArF 准分子激光器, 激光束斑直径为30 μm,激光剥蚀深度为20~40 μm。测试He 为剥蚀物质的载气,用NIST SRM 610 人工合成硅酸盐玻璃标准作为参考物质调试仪器; 进行单点剥蚀采样;每5个测试样品前后,测试 91500标样一次,每12个测试点前后测试1次 NIST610和GJ-1。锆石年龄计算采用标准锆石 91500作为外标,元素含量采用美国国家标准物质 局人工合成硅酸盐玻璃NISTSRM610作为外标,<sup>29</sup>Si 作为内标元素进行校正。数据采集处理采用 GLITTER(Version4.0, Mcquaire University),并采用 Andersen软件对测试数据进行普通铅校正,年龄计 算及谐和图绘制采用ISOPLOT(3.0版)软件完成。 详细的实验原理和流程及仪器参见柳小明等(2002) 和Yuan et al.(2003)。

## 3.2 元素分析方法

采集6件新鲜未蚀变样品进行常量、稀土和微量元素分析,其中片麻状黑云母花岗岩样品2件(编号PM003/3-1、PM003/4-1)、片麻状黑云正长花岗岩样品2件(编号D3135/1、D3136/1)和片麻状二云正长花岗岩样品3件(编号D4240/1、D4240/2、D4240/3)。常量、稀土、微量元素分析在核工业二〇三研究所分析测试中心完成。FeO采用容量法分析,依据标准GB/T14506.14-2010;其余常量元素、TFe<sub>2</sub>O<sub>3</sub>和微量元素中P、Ba、V、Cr、Rb、Sr、Zr、Sc均采用XRF法分析,使用仪器为荷兰帕纳科公司制造的AxiosX射线光谱仪,依据标准GB/T14506.28-2010;所有稀土元素及微量元素中Co、Ni、Nb、Hf、

Ta、Th、U采用ICP-MS法分析,使用仪器为Thermo Fisher Scientific公司制造的XSERIES2型ICP-MS, 依据标准GB/T14506.30-2010;TFe<sub>2</sub>O<sub>3</sub>值通过计算公 式TFe<sub>2</sub>O<sub>3</sub>=Fe<sub>2</sub>O<sub>3</sub>+FeO×1.1113得出。常量元素分析 数据中烧失量值介于0.40%~0.66%,总量在99.05%~ 99.93%,满足精度标准要求;常量元素分析误差小于 1%,微量元素和稀土元素分析精度优于5%。

## 4 年代学特征

## 4.1 样品 PM003/4 锆石 U-Pb 定年

样品 PM003/4 中的锆石颜色为棕褐色,晶体较完整,晶体晶面粗糙不光亮,有麻点状、小丘状熔(溶)蚀,少数晶体有蚀坑,浑圆度为次棱角状一次浑圆状。锆石长度介于135~370 µm,宽度介于60~200 µm,长宽比为2:1~4:1。阴极发光(CL)显示(图3),这些锆石具有明显的震荡环带,指示它们为岩浆成因锆石(吴元保等,2004),部分锆石具有继承的核部,个别锆石的边部在 CL 图像上显示为白色的变质增生边,但由于其边缘太窄而无法进行同位素测年。锆石 Th/U=0.21~0.59,全部介于0.2~1.0,也显示了典型的壳源岩浆锆石的特征(Rutatto, 2002)。

对样品PM003/4的28粒锆石进行了30个分析 点测试(表1),其中有25个测点的数据组成一个年 龄密集区(图4),<sup>206</sup>Pb/<sup>238</sup>U年龄介于881~886 Ma,加



图 3 片麻状花岗岩(PM003-4)中锆石的CL图像和U-Pb年龄值 Fig.3 Zircon CL image and U-Pb ages of gneissic granite(PM003/4)

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表1 片麻状花岗岩(样品 PM003/4)锆石 LA-ICP-MS U-Pb 同位素分析结果表

Table 1 LA-ICP-MS zircon U-Pb isotopic analysis results of gneissic gr	canite(sample PM003-4)
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占旦	北和中	Th/II				同位詞	素比值						同位	立素年	三龄/Ma			
<b>点</b> 与	咱们交	TH/U	<sup>207</sup> Pb/ <sup>206</sup> Pb	1σ	207Pb/235U	1σ	206Pb/238U	1σ	208Pb/232Th	1σ	207Pb/206U	1σ	<sup>207</sup> Pb/ <sup>235</sup> U	J 1σ <sup>2</sup>	<sup>06</sup> Pb/ <sup>238</sup> Th	$1\sigma^{20}$	<sup>8</sup> Pb/ <sup>232</sup> Tł	n 1σ
01	111.27%	0.30	0.07353	0.00263	1.18946	0.03586	0.11732	0.00149	0.03485	0.00093	1029	71	796	17	715	9	692	18
02	105.64%	0.40	0.07436	0.00178	1.5018	0.02289	0.14651	0.00141	0.04678	0.00061	1051	47	931	9	881	8	924	12
03	112.02%	0.41	0.0743	0.00172	1.20342	0.01698	0.11749	0.00111	0.03876	0.00046	1050	46	802	8	716	6	769	9
04	102.13%	0.39	0.07069	0.00309	1.42973	0.05614	0.14672	0.00223	0.04187	0.0014	948	87	901	23	883	13	829	27
05	103.49%	0.59	0.07213	0.00222	1.45996	0.03576	0.14684	0.00169	0.04364	0.00078	990	61	914	15	883	10	863	15
06	102.07%	0.40	0.07062	0.00164	1.42776	0.02041	0.14667	0.00139	0.04315	0.00053	946	47	901	9	882	8	854	10
07	108.98%	0.44	0.07141	0.00169	1.15957	0.01582	0.11771	0.00108	0.03573	0.0004	969	47	782	7	717	6	710	8
08	103.95%	0.41	0.07259	0.00262	1.47142	0.04453	0.14695	0.00189	0.04583	0.00104	1003	72	919	18	884	11	906	20
09	129.07%	0.43	0.10706	0.0025	2.34417	0.03121	0.15873	0.0015	0.07982	0.00088	1750	42	1226	9	950	8	1552	17
10	107.39%	0.39	0.07635	0.00215	1.55072	0.03186	0.14723	0.00156	0.04848	0.00082	1104	55	951	13	885	9	957	16
11	107.27%	0.30	0.07619	0.00227	1.54554	0.03493	0.14706	0.00163	0.0462	0.00098	1100	58	949	14	884	9	913	19
12	109.55%	0.21	0.07198	0.0024	1.16998	0.03164	0.11783	0.00139	0.03635	0.00082	986	67	787	15	718	8	722	16
13	106.25%	0.31	0.07498	0.00484	1.51585	0.09256	0.14657	0.00323	0.03986	0.00252	1068	125	937	37	882	18	790	49
14	104.31%	0.38	0.07291	0.00173	1.47471	0.02104	0.14664	0.00138	0.042	0.00051	1011	47	920	9	882	8	832	10
15	104.50%	0.44	0.07312	0.00201	1.47922	0.02929	0.14666	0.00153	0.04234	0.00067	1017	55	922	12	882	9	838	13
16	111.28%	0.39	0.08059	0.00194	1.63135	0.02408	0.14676	0.0014	0.05062	0.00064	1212	47	982	9	883	8	998	12
17	102.98%	0.30	0.07158	0.00173	1.45077	0.02158	0.14695	0.00139	0.04257	0.00059	974	48	910	9	884	8	843	11
18	102.85%	0.43	0.07144	0.00184	1.44753	0.02508	0.14691	0.00146	0.04235	0.00061	970	52	909	10	884	8	838	12
19	109.40%	0.55	0.07839	0.00219	1.58254	0.03235	0.14637	0.00157	0.04489	0.00072	1157	54	963	13	881	9	888	14
20	106.35%	0.40	0.07518	0.00188	1.52329	0.02494	0.14692	0.00144	0.04783	0.00065	1073	49	940	10	884	8	944	13
21	103.56%	0.33	0.07222	0.00169	1.46544	0.02024	0.14712	0.00137	0.04506	0.00056	992	47	916	8	885	8	891	11
22	109.00%	0.33	0.07807	0.00181	1.58153	0.02147	0.14689	0.00137	0.05552	0.00066	1149	45	963	8	884	8	1092	13
23	104.15%	0.48	0.07291	0.00172	1.48146	0.02122	0.14733	0.00139	0.04389	0.00052	1012	47	923	9	886	8	868	10
24	102.40%	0.48	0.07096	0.00171	1.43722	0.0217	0.14687	0.0014	0.04264	0.00052	956	48	905	9	883	8	844	10
25	109.56%	0.40	0.07868	0.00188	1.59184	0.02376	0.14672	0.00141	0.04974	0.00063	1164	47	967	9	883	8	981	12
26	108.39%	0.50	0.07729	0.00192	1.56046	0.02566	0.14642	0.00145	0.04978	0.00066	1129	49	955	10	881	8	982	13
27	107.70%	0.41	0.07658	0.00185	1.54737	0.02373	0.14653	0.00142	0.04743	0.00063	1110	47	949	9	882	8	937	12
28	104.26%	0.30	0.0729	0.00171	1.47423	0.02112	0.14667	0.00139	0.04653	0.00061	1011	47	920	9	882	8	919	12
29	112.44%	0.44	0.08196	0.00209	1.66021	0.02886	0.14691	0.00149	0.05338	0.00076	1245	49	994	11	884	8	1051	15
30	106.11%	0.46	0.07499	0.00184	1.52198	0.02439	0.1472	0.00144	0.04218	0.00057	1068	48	939	10	885	8	835	11

权平均年龄为(883.1±3.3)Ma(MSWD=0.028),这25 个测点位于锆石震荡环带上,Th/U均大于0.1,为岩 浆锆石的特征,因此(883.1±3.3)Ma的年龄值代表了 片麻状花岗岩的形成时代,属青白口纪。另外,测点9 位于锆石核部,年龄值((950±8)Ma)应代表了继承锆 石年龄,与笔者在冰沟南组火山岩中获得的最新年龄 ((944.7±6.4)Ma)基本一致(曾忠诚等,2019);测点1、 3、7、12((715±9)Ma、(716±6)Ma、(717±6)Ma、(718±8) Ma)的位置均靠近锆石白色蚀变边缘,年龄值可能代 表混合了后期变质或其它地质事件影响的混合年龄。

#### 4.2 样品 PM004-6 锆石 U-Pb 定年

样品 PM004-6中的锆石自形程度较好,多呈长 柱状,透明度较好,锆石长度介于135~247 μm,宽度 介于59~129 μm,长宽比为1.5:1~2.5:1。阴极发光 (CL)显示(图5),所有锆石具有清晰的岩浆振荡环 带特征,指示它们为岩浆成因锆石(吴元保等, 2004),部分锆石具有继承的核部,个别锆石的边部 在 CL 图像上显示为白色的变质增生边,但由于其 边缘太窄而无法进行同位素测年。锆石 Th/U= 0.19~0.67,全部介于0.2~1.0,也显示了典型的壳源



图4 片麻状花岗岩(PM003-4)锆石U-Pb谐和图 Fig.4 LA-ICP-MS zircon U-Pb concordia diagram for gneissic granite(PM003/4)



图5 片麻状花岗岩(PM004-6)中锆石的CL图像和U-Pb年龄值 Fig.5 Zircon CL image and U-Pb ages of gneissic granite(PM004-6)

岩浆锆石的特征(Rutatto, 2002)。

对样品 PM004-6的23粒锆石进行了24个分析 点测试(表2),其中20个测点的数据组成一个年龄 密集区(图6),<sup>206</sup>Pb/<sup>238</sup>U年龄介于881~887 Ma,加权 平均年龄为(883.0±3.3)Ma(MSWD=0.062),这20个 测点位于锆石震荡环带的微区,Th/U均大于0.1,为 岩浆锆石特征,因此(883.0±3.3)Ma的年龄代表了片 麻状花岗岩的形成时代,属青白口纪。另外,测点15、 19于锆石的核部,年龄值(1122±9)Ma、(956±8)Ma应 该代表了继承锆石年龄,其中(956±8)Ma的年龄值与 笔者最新在冰沟南组火山岩中获得的年龄(944.7± 6.4)Ma基本一致。测点1、4的位置均靠近锆石白色 蚀变边缘,年龄值(798±7)Ma、(804±7)Ma可能代表混 合了后期变质或其他地质事件影响的混合年龄。

## 5 岩石地球化学特征

片麻状花岗岩的主量、稀土及微量元素分析结 果见表3。

## 5.1 主量元素特征

在TAS分类图解中,绝大部分样品分布在花岗 岩区(图7),与岩相学观察结果基本一致。片麻状 花岗岩所有样品具有高SiO<sub>2</sub>(69.33%~74.88%,平均 值72.75%)、Al<sub>2</sub>O<sub>3</sub>(13.48%~14.22%,平均值 13.89%)、K<sub>2</sub>O(2.96%~4.30%,平均值3.45%)和全碱 (5.59%~6.97%,平均值6.37%)含量,低Na<sub>2</sub>O(2.58% ~3.24%,平均值2.92%)、MgO(0.37%~1.12%,平均

表2 片麻状花岗岩(样品PM004–6)锆石LA–ICP–MS U–Pb 同位素分析结果
Table2 LA-ICP-MS Zircon U-Pb isotopic analyses of gneissic granite(sample PM004-6)

占早	波和审	Th/II				同位家	素比值		同位素年龄/Ma										
尻ち	、5 咱们又 111/	TH/U	<sup>207</sup> Pb/ <sup>206</sup> Pb	$1\sigma$	207Pb/235U	$1\sigma$	206Pb/238U	$1\sigma$	208Pb/232Th	1σ	<sup>207</sup> Pb/ <sup>206</sup> U	$1 1 \sigma^2$	<sup>207</sup> Pb/ <sup>235</sup> U	$J 1 \sigma^2$	<sup>206</sup> Pb/ <sup>238</sup> T	$11\sigma^2$	<sup>08</sup> Pb/ <sup>232</sup> Th	ι 1 <i>σ</i>	
01	165.31%	0.36	0.14674	0.00306	2.66722	0.0251	0.1318	0.00116	0.12103	0.00102	2308	35	1319	7	798	7	2309	18	
02	101.58%	0.39	0.07017	0.00148	1.42377	0.01421	0.14714	0.00129	0.04445	0.0004	933	43	899	6	885	7	879	8	
03	108.61%	0.34	0.07766	0.0017	1.57302	0.01797	0.14688	0.00132	0.0505	0.00052	1138	43	960	7	884	7	996	10	
04	164.07%	1.09	0.1456	0.00307	2.66759	0.02625	0.13286	0.00118	0.03951	0.00034	2295	36	1320	7	804	7	783	7	
05	101.02%	0.36	0.06954	0.00148	1.40339	0.01431	0.14635	0.00129	0.04661	0.00051	915	43	890	6	881	7	921	10	
06	108.04%	0.19	0.07701	0.00165	1.55961	0.01663	0.14686	0.00131	0.07022	0.00074	1122	42	954	7	883	7	1372	14	
07	102.07%	0.32	0.07064	0.00163	1.43157	0.01929	0.14697	0.00137	0.04259	0.00056	947	46	902	8	884	8	843	11	
08	110.17%	0.37	0.07919	0.00176	1.59525	0.01931	0.14608	0.00133	0.05065	0.00056	1177	43	968	8	879	8	999	11	
09	101.71%	0.29	0.07021	0.00158	1.41924	0.0178	0.1466	0.00134	0.04182	0.00055	935	45	897	7	882	8	828	11	
10	101.94%	0.42	0.07044	0.0016	1.42435	0.01856	0.14665	0.00135	0.04329	0.0005	941	46	899	8	882	8	857	10	
11	102.30%	0.36	0.07086	0.00201	1.43509	0.03038	0.14688	0.00158	0.04087	0.00075	953	57	904	13	883	9	810	15	
12	103.04%	0.32	0.07163	0.00155	1.44993	0.01596	0.1468	0.00131	0.04475	0.00044	975	44	910	7	883	7	885	9	
13	100.88%	0.28	0.06939	0.00148	1.40503	0.01439	0.14686	0.0013	0.04372	0.0004	910	43	891	6	883	7	865	8	
14	104.36%	0.21	0.07312	0.00156	1.48402	0.01534	0.14721	0.00131	0.04724	0.00047	1017	43	924	6	885	7	933	9	
15	102.74%	0.48	0.08056	0.00176	2.11152	0.02385	0.19009	0.00172	0.06527	0.00062	1211	42	1153	8	1122	9	1278	12	
16	101.64%	0.24	0.07021	0.00149	1.42293	0.01434	0.14699	0.0013	0.04333	0.0004	935	43	899	6	884	7	857	8	
17	103.28%	0.43	0.07192	0.00159	1.45691	0.01697	0.14692	0.00133	0.03951	0.00042	984	44	913	7	884	7	783	8	
18	108.84%	0.43	0.07778	0.00173	1.56885	0.01897	0.1463	0.00134	0.03792	0.0004	1141	44	958	8	880	8	752	8	
19	99.48%	0.56	0.07038	0.00157	1.55097	0.0186	0.15984	0.00146	0.04648	0.00053	939	45	951	7	956	8	918	10	
20	101.49%	0.26	0.07006	0.0015	1.41925	0.0146	0.14694	0.0013	0.04383	0.00041	930	43	897	6	884	7	867	8	
21	102.57%	0.59	0.07117	0.00154	1.44138	0.01572	0.14691	0.00132	0.04217	0.00038	962	44	906	7	884	7	835	7	
22	105.07%	0.36	0.07394	0.0016	1.50337	0.01635	0.14747	0.00132	0.03797	0.00037	1040	43	932	7	887	7	753	7	
23	104.24%	0.61	0.07286	0.00163	1.4724	0.01783	0.14657	0.00134	0.04176	0.00041	1010	44	919	7	882	8	827	8	
24	103.29%	0.67	0.07184	0.00163	1.45058	0.01861	0.14647	0.00135	0.04253	0.00041	981	46	910	8	881	8	842	8	

注: Mg<sup>#</sup>=100×(MgO/40.3044)/(MgO/40.3044+TFeO/71.844); *AR*=(Al<sub>2</sub>O<sub>3</sub>+CaO+Na<sub>2</sub>O+K<sub>2</sub>O)/(Al<sub>2</sub>O<sub>3</sub>+CaO-Na<sub>2</sub>O-K<sub>2</sub>O); A/CNK=摩尔Al<sub>2</sub>O<sub>3</sub>/(CaO+Na<sub>2</sub>O+K<sub>2</sub>O)<sub>0</sub>)



图6 片麻状花岗岩(PM004-6)锆石U-Pb谐和图 Fig.6 LA-ICP-MS zircon U-Pb concordia diagram for gneissic granite(PM004-6)

值 0.64%)、CaO(1.69%~2.97%,平均值 2.15%)和 TiO<sub>2</sub>(0.21%~0.44%,平均值 0.30%)含量的特征。岩 石样品铝饱和指数 A/CNK 值 (0.98~1.24,平均值 1.12),A/NK 值 >1(1.55~1.79),显示岩石主要为过 铝质花岗岩(图 8)。岩石的碱度率指数 AR 为1.93~ 2.42,具有富铝的特点;里特曼指数 σ为1.03~1.85,平 均值 1.38,显示钙碱系列岩石特征,在 K<sub>2</sub>O-SiO<sub>2</sub>图 解中岩石全部落入钙碱性系列与高钾钙碱性系列范 围(图 9),在SiO<sub>2</sub>-Zr图解中样品全部 S型花岗岩区 域(图 10)。以上地球化学分析显示片麻状花岗岩具 有高硅、铝、钙碱性-高钾钙碱性过铝质花岗岩特征, 均与 S型花岗岩主量元素特征相同。

## 5.2 稀土元素特征

片麻状花岗岩7件样品稀土总量ΣREE= 148.99×10<sup>-6</sup>~254.78×10<sup>-6</sup>(平均值为194.80×10<sup>-6</sup>), ΣLREE/ΣHREE值为3.18~5.07,平均值3.95;轻重稀 土分馏明显(La/Yb)<sub>№</sub>=8.47~15.65(平均为11.09),其 中轻稀土分馏较强(La/Sm)<sub>№</sub>=3.22~6.42(平均为 5.18),重稀土分馏相对较弱,(Gd/Yb)<sub>№</sub>=1.23~2.18 (平均为1.67)。具Eu负异常(*δ*Eu=0.48~0.82),暗示 岩浆在形成过程中可能存在斜长石的分离结晶作用 或源区有斜长石的残留。在球粒陨石标准化稀土元 素配分图中(图11a),各样品总体具有一致的变化趋 势,显示LREE富集、HREE平坦的右倾型分布特征, 存在Eu元素的"V"型谷,表现为非常一致的"右倾海 鸥型",显示了典型的S型花岗岩稀土分配特征。

#### 5.3 微量元素特征

在原始地幔标准化微量元素蛛网图中(图11b),显示岩石富集Rb、Th、LREE等大离子亲石元素,中等亏损Ba,强烈亏损Nb、Sr、P、Hf、Ti等高场强元素,元素的丰度特征与典型陆-陆碰撞S型花岗岩(Pearce et al., 1984)相似,也与附近同碰撞型盖里克片麻岩、亚干布阳片麻岩和科克萨依花岗质片麻岩蛛网曲线特征(李琦等, 2015, 2018;陈红杰等, 2018)基本一致。

## 6 讨 论

## 6.1 岩体成因

本文片麻状花岗岩属于S型花岗岩,是与地壳物质熔融有关的产物。岩石的TFeO/MgO比值为 2.68~6.28; Al<sub>2</sub>O<sub>3</sub>/TiO<sub>2</sub>=32.32~66.38, 均小于 100;

CaO/Na<sub>2</sub>O=0.60~1.02,均大于 0.3; K<sub>2</sub>O/ Na<sub>2</sub>O=0.95~ 1.67,比值多大于 1,与地壳沉积岩部分熔融而成的 S型花岗岩地球化学特征(SiO<sub>2</sub> < 74%、Al<sub>2</sub>O<sub>3</sub>/TiO<sub>2</sub> < 100、CaO/Na<sub>2</sub>O > 0.3、K<sub>2</sub>O/ Na<sub>2</sub>O > 1)(路凤香和桑隆 康,2002)一致。Mg<sup>#</sup>指数为 22.10~39.91,明显小于 玄武岩熔融实验熔体成分的 Mg<sup>#</sup>值(40)(Rapp et al., 1995),也指示片麻状花岗岩与地壳物质部分熔 融有关,无地幔物质加入。

前人对中国花岗岩研究发现(王中刚,1989;赵 振华等,1991),典型的地壳重熔型花岗岩以二长花 岗岩、钾质花岗岩、碱长花岗岩多见,ΣREE总量平 均为193×10<sup>-6</sup>,(La/Yb)<sub>N</sub>为平均小于10,δEu<0.5, 花岗岩稀土元素归一化图解为右倾的"V"型分布模 式;而壳幔型花岗岩类多以闪长岩、花岗闪长岩、英 云闪长岩及石英闪长岩为主,其ΣREE总量平均为 158.7×10<sup>-6</sup>,(La/Yb)<sub>N</sub>平均大于10,δEu平均为0.84, 且归一化稀土元素为右倾的较平滑型分布模式。 本文研究7件样品稀土总量平均值为194.08×10<sup>-6</sup>, (La/Yb)<sub>N</sub>大多小于10,稀土元素分布模式为右倾的 "V"型分布,显示为地壳重熔型花岗岩特征。

岩石的微量元素中Nb和Ta含量分别为10.7× 10<sup>-6</sup>~30×10<sup>-6</sup>和1.12×10<sup>-6</sup>~3.40×10<sup>-6</sup>,与地壳岩石中 Nb  $Ta(Nb=8\times10^{-6} \sim (11.5\pm2.6)\times10^{-6}, Ta=0.7\times10^{-6} \sim 10^{-6}$ (0.92±0.12)×10<sup>-6</sup>)(Barth et al., 2000)含量接近;而 目、Nb/Ta(5.1~12.22,平均为9.26)、K/Rb(121.59~ 213.09,平均为155.71)和La/Nb(1.11~4.93,平均为 2.26)分别与地壳岩石中的相应值(12~13)、(150~ 350)和2.2也非常接近(Barth et al., 2000; Dostal and Chatterjee, 2000);样品的 Rb/Nb 比值(6.15~15.81,平 均值为10.31)和K/Nb比值(832.55~3334.66,平均值 为1675.87)与地壳相应比值(5.36~6.55和1498~ 2976)近似, 而明显区别于地幔相应比值(0.24~0.89 和 249~349)(Rudnick and Fountain, 1995); Ti/Zr 值 (8.59~18.36,平均值为13.36)与地壳Ti/Zr平均值(< 20)一致。在微量元素蛛网图中,富集大离子亲石元 素(Rb、Th、LREE等),亏损Ba、Sr、Ti、P、Nb等元素, 与典型的陆壳重熔型花岗岩相似。以上微量元素 特征均显示壳源演化岩石的特征。

实验岩石学研究表明,地壳中碎屑沉积岩类部 分熔融形成偏酸性的过铝质花岗岩类,泥砂质沉积 岩类部分熔融可能形成强富铝和富钾质的花岗岩

| <u>1 D4240/1 D4240/2 D4240/3</u><br>2.8 2.15 2.28 | 0.47 0.37 0.33 | 24.7 17.6 19 |              | 2 254.78 148.99 150.57 | 2 254.78 148.99 150.57<br>5.07 3.93 3.77                                  | 2 254.78 148.99 150.57<br>5.07 3.93 3.77<br>0.48 0.71 0.82                  | 2 254.78 148.99 150.57<br>5.07 3.93 3.77<br>0.48 0.71 0.82<br>0.90 0.87 0.92 | 2 254.78 148.99 150.57<br>5.07 3.93 3.77<br>0.48 0.71 0.82<br>0.90 0.87 0.92<br>14.43 10.47 9.60 | 2 254.78 148.99 150.57<br>5.07 3.93 3.77<br>0.48 0.71 0.82<br>0.90 0.87 0.92<br>14.43 10.47 9.60<br>5.70 6.28 6.27 | 2 254.78 148.99 150.57<br>5.07 3.93 3.77<br>0.48 0.71 0.82<br>0.90 0.87 0.92<br>14.43 10.47 9.60<br>5.70 6.28 6.27<br>1.66 1.52 1.23  | 2         254.78         148.99         150.57           5.07         3.93         3.77           5.07         3.93         3.77           0.48         0.71         0.82           0.90         0.87         0.92           14.43         10.47         9.60           5.70         6.28         6.27           1.66         1.52         1.23           8.3         8.4         7.1 | 2         254.78         148.99         150.57           5.07         3.93         3.77           5.07         3.93         3.77           0.48         0.71         0.82           0.90         0.87         0.92           14.43         10.47         9.60           5.70         6.28         6.27           1.66         1.52         1.23           8.3         8.4         7.1           28.1         27.7         25.4  | 2     254.78     148.99     150.57       5.07     3.93     3.77       5.07     3.93     3.77       0.48     0.71     0.82       0.90     0.87     0.92       14.43     10.47     9.60       5.70     6.28     6.27       1.66     1.52     1.23       8.3     8.4     7.1       28.1     27.7     25.4       16.7     19.9     17.1   | 2     254.78     148.99     150.57       5.07     3.93     3.77       5.07     3.93     3.77       0.48     0.71     0.82       0.90     0.87     0.92       14.43     10.47     9.60       5.70     6.28     6.27       1.66     1.52     1.23       8.3     8.4     7.1       28.1     27.7     25.4       16.7     19.9     17.1       4.18     2.52     2.47   | 2       254.78       148.99       150.57         5.07       3.93       3.77         5.07       3.93       3.77         0.48       0.71       0.82         0.90       0.87       0.92         14.43       10.47       9.60         5.70       6.28       6.27         1.66       1.52       1.23         8.3       8.4       7.1         28.1       27.7       25.4         1.67       19.9       17.1         4.18       2.52       2.47         4.56       3.76       3.74  | 2       254.78       148.99       150.57         5.07       3.93       3.77         5.07       3.93       3.77         0.48       0.71       0.82         0.90       0.87       0.92         14.43       10.47       9.60         5.70       6.28       6.27         1.66       1.52       1.23         8.3       8.4       7.1         28.1       27.7       25.4         16.7       19.9       17.1         4.18       2.52       2.47         4.56       3.76       3.74         17.6       14.3       21.2 | 2         254.78         148.99         150.57           5.07         3.93         3.77           5.07         3.93         3.77           0.48         0.71         0.82           0.90         0.87         0.92           14.43         10.47         9.60           5.70         6.28         6.27           1.66         1.52         1.23           8.3         8.4         7.1           28.1         27.7         25.4           16.7         19.9         17.1           4.18         2.52         2.47           4.56         3.76         3.74           17.6         14.3         21.2           17.6         14.3         21.2           15.3         11.9         17.6 | 2         254.78         148.99         150.57           5.07         3.93         3.77           5.07         3.93         3.77           0.48         0.71         0.82           0.90         0.87         0.92           14.43         10.47         9.60           5.70         6.28         6.27           1.66         1.52         1.23           8.3         8.4         7.1 
         28.1         27.7         25.4           16.7         19.9         17.1           4.18         2.52         2.47           4.56         3.76         3.74           17.6         14.3         21.2           17.6         14.3         21.2           15.3         11.9         17.6           15.3         16.6         15.8   | 2         254.78         148.99         150.57           5.07         3.93         3.77           5.07         3.93         3.77           0.48         0.71         0.82           0.90         0.87         0.92           14.43         10.47         9.60           5.70         6.28         6.27           1.66         1.52         1.23           8.3         8.4         7.1           28.1         27.7         25.4           16.7         19.9         17.1           4.18         2.52         2.47           4.56         3.76         3.74           17.6         14.3         17.1           4.18         2.52         2.47           4.56         3.76         3.74           17.6         14.3         21.2           15.3         11.9         17.6           16.1         14.3         21.2           15.3         16.6         15.8           16.1         11.9         111 | 2       254.78       148.99       150.57         5.07       3.93       3.77         5.07       3.93       3.77         0.48       0.71       0.82         0.90       0.87       0.92         14.43       10.47       9.60         5.70       6.28       6.27         1.66       1.52       1.23         8.3       8.4       7.1         28.1       27.7       25.4         16.7       19.9       17.1         4.18       2.52       2.47         4.56       3.76       3.74         15.3       11.9       17.6         15.3       15.3       11.9       17.6         15.3       16.6       15.8         16.3       16.6       15.8         16.3       16.6       15.8         16.4       119.9       111         16.4       119.9       111         16.8       569.8       669.8   
   | 2     254.78     148.99     150.57       5.07     3.93     3.77       5.07     3.93     3.77       0.48     0.71     0.82       0.90     0.87     0.92       14.43     10.47     9.60       5.70     6.28     6.27       1.66     1.52     1.23       8.3     8.4     7.1       28.1     27.7     25.4       16.7     19.9     17.1       4.18     2.52     2.47       4.56     3.76     3.74       17.6     14.3     21.2       15.3     11.9     17.6       15.3     11.9     17.6       16.3     16.6     15.8       15.3     11.9     17.6       16.3     16.6     15.8       16.3     16.6     15.8       16.4     119.9     111       16.84.5     569.8     669.8       184.5     176.5     187.3  | 2       2534.78       148.99       150.57         5.07       3.93       3.77         5.07       3.93       3.77         0.48       0.71       0.82         0.90       0.87       0.92         14.43       10.47       9.60         5.70       6.28       6.27         1.66       1.52       1.23         8.3       8.4       7.1         28.1       27.7       25.4         16.7       19.9       17.1         4.18       2.52       2.47         4.18       2.52       2.47         4.18       2.52       2.47         17.6       14.3       21.2         17.6       14.3       21.2         17.6       14.3       21.2         15.3       11.9       17.6         16.3       16.6       15.8         16.3       16.6       15.8         16.3       16.6       15.8         16.3       16.6       17.6         17.6       119.9       111         16.3       16.6       15.8         16.3       16.6       15.8         16.4       < | 2       254.78       148.99       150.57         5.07       3.93       3.77         5.07       3.93       3.77         0.48       0.71       0.82         0.90       0.87       0.92         14.43       10.47       9.60         5.70       6.28       6.27         1.66       1.52       1.23         8.3       8.4       7.1         28.1       27.7       25.4         16.7       19.9       17.1         4.18       2.52       2.47         4.56       3.76       3.74         17.6       14.3       21.2         17.6       14.3       21.2         17.6       14.3       21.2         17.6       14.3       21.2         16.3       16.6       15.8         16.3       16.6       15.8         16.3       16.6       15.8         184.5       176.5       187.3         30       27.7       29.1         33.4       3.32       3.4  | 2        
2534.78         148.99         150.57           5.07         3.93         3.77           5.07         3.93         3.77           0.48         0.71         0.82           0.90         0.87         0.92           14.43         10.47         9.60           5.70         6.28         6.27           1.66         1.52         1.23           8.3         8.4         7.1           28.1         27.7         25.4           16.7         19.9         17.1           16.7         19.9         17.1           4.18         2.52         2.47           4.56         3.76         3.74           17.6         14.3         17.6           17.6         14.3         2.12           15.3         11.9         17.6           16.7         19.9         111           16.3         16.6         15.8           16.4         19.9         111           16.1         19.9         111           17.6         14.3         3.76           16.4         19.9         17.6           16.1         14.3         17  | 2       254.78       148.99       150.57         5.07       3.93       3.77         5.07       3.93       3.77         0.48       0.71       0.82         0.90       0.87       0.92         14.43       10.47       9.60         5.70       6.28       6.27         1.66       1.52       1.23         8.3       8.4       7.1         28.1       27.7       25.4         16.7       19.9       17.1         16.7       19.9       17.1         4.18       2.52       2.47         4.56       3.76       3.74         17.6       14.3       17.6         17.6       14.3       2.12         15.3       11.9       17.6         16.4       14.3       2.12         15.3       16.6       15.8         16.4       19.9       111         15.3       16.6       15.8         16.1       19.9       111         15.3       16.6       15.8         3.3       3.76.5       187.3         3.3       3.34       3.35         3.4   | 2       254.78       148.99       150.57         5.07       3.93       3.77         5.07       3.93       3.77         0.48       0.71       0.82         0.90       0.87       0.92         14.43       10.47       9.60         5.70       6.28       6.27         14.43       10.47       9.60         5.70       6.28       6.27         1.66       1.52       1.23         8.3       8.4       7.1         28.1       27.7       25.4         1.67       19.9       17.1         4.18       2.52       2.47         4.56       3.76       3.74         17.6       14.3       21.2         17.6       14.3       27.7         15.3       11.9       17.6         16.4       14.3       21.2         15.3       16.6       15.8         16.4       14.3       21.2         15.3       16.6       15.8         3.0       2.77       29.1         3.0       27.7       29.1         3.14       3.3       3.4         3.18  | 2       254.78       148.99       150.57         5.07       3.93       3.77         5.07       3.93       3.77         0.48       0.71       0.82         0.90       0.87       0.92         14.43       10.47       9.60         5.70       6.28       6.27         1.66       1.52       1.23         8.3       8.4       7.1         28.1       27.7       25.4         16.7       19.9       17.1         4.18       2.52       2.47         4.56       3.76       3.74         17.6       14.3       21.2         16.7       19.9       17.1         4.18       2.52       2.47         4.56       3.76       3.74         17.6       14.3       21.2         17.6       14.3       21.2         15.3       11.9       17.6         16.3       16.6       15.8         1       50.4       199.9         15.3       15.6       17.5         16.4       199.9       17.1         16.7       199.9       17.6         16.6 <t< th=""><th>2       2534.78       148.99       150.57         5.07       3.93       3.77         5.07       3.93       3.77         0.48       0.71       0.82         0.90       0.87       0.92         14.43       10.47       9.60         5.70       6.28       6.27         1.66       1.52       1.23         8.3       8.4       7.1         28.1       27.7       25.4         16.7       19.9       17.1         4.18       2.52       2.47         4.18       2.52       2.47         4.18       2.52       2.47         4.18       2.52       2.47         15.3       11.9       17.6         17.6       14.3       21.2         15.3       11.9       17.6         16.3       16.6       15.8         16.3       16.6       15.8         17.6       14.2       138.2         3.0       27.7       29.1         3.0       27.7       29.1         3.0       27.7       29.1         3.14      
119.9       111         184.5       <t< th=""><th>2       254.78       148.99       150.57         5.07       3.93       3.77         5.07       3.93       3.77         0.48       0.71       0.82         0.90       0.87       0.92         14.43       10.47       9.60         5.70       6.28       6.27         1.66       1.52       1.23         8.3       8.4       7.1         28.1       27.7       25.4         16.7       19.9       17.1         28.1       27.7       25.4         16.7       19.9       17.1         4.18       2.52       2.47         4.56       3.76       3.74         17.6       14.3       21.2         17.6       14.3       21.2         16.3       16.6       15.8         16.3       16.6       15.8         3.0       27.7       29.1         3.19       176.5       187.3         3.19       3.34       3.32         3.19       3.34       3.35         3.19       27.7       29.1         3.34       3.35       3.4         3.34       <t< th=""><th><math display="block"> \begin{array}{cccccccccccccccccccccccccccccccccccc</math></th><th><math display="block"> \begin{array}{cccccccccccccccccccccccccccccccccccc</math></th></t<></th></t<></th></t<> | 2       2534.78       148.99       150.57         5.07       3.93       3.77         5.07       3.93       3.77         0.48       0.71       0.82         0.90       0.87       0.92         14.43       10.47       9.60         5.70       6.28       6.27         1.66       1.52       1.23         8.3       8.4       7.1         28.1       27.7       25.4         16.7       19.9       17.1         4.18       2.52       2.47         4.18       2.52       2.47         4.18       2.52       2.47         4.18       2.52       2.47         15.3       11.9       17.6         17.6       14.3       21.2         15.3       11.9       17.6         16.3       16.6       15.8         16.3       16.6       15.8         17.6       14.2       138.2         3.0       27.7       29.1         3.0       27.7       29.1         3.0       27.7       29.1         3.14       119.9       111         184.5 <t< th=""><th>2       254.78       148.99       150.57         5.07       3.93       3.77         5.07       3.93       3.77         0.48       0.71       0.82         0.90       0.87       0.92         14.43       10.47       9.60         5.70       6.28       6.27         1.66       1.52       1.23         8.3       8.4       7.1         28.1       27.7       25.4         16.7       19.9       17.1         28.1       27.7       25.4         16.7       19.9       17.1         4.18       2.52       2.47         4.56       3.76       3.74         17.6       14.3       21.2         17.6       14.3       21.2         16.3       16.6       15.8         16.3       16.6       15.8         3.0       27.7       29.1         3.19       176.5       187.3         3.19       3.34       3.32         3.19       3.34       3.35         3.19       27.7       29.1         3.34       3.35       3.4         3.34       <t< th=""><th><math display="block"> \begin{array}{cccccccccccccccccccccccccccccccccccc</math></th><th><math display="block"> \begin{array}{cccccccccccccccccccccccccccccccccccc</math></th></t<></th></t<>   | 2       254.78       148.99       150.57         5.07       3.93       3.77         5.07       3.93       3.77         0.48       0.71       0.82         0.90       0.87       0.92         14.43       10.47       9.60         5.70       6.28       6.27         1.66       1.52       1.23         8.3       8.4       7.1         28.1       27.7       25.4         16.7       19.9       17.1         28.1       27.7       25.4         16.7       19.9       17.1         4.18       2.52       2.47         4.56       3.76       3.74         17.6       14.3       21.2         17.6       14.3       21.2         16.3       16.6       15.8         16.3       16.6       15.8         3.0       27.7       29.1         3.19       176.5       187.3         3.19       3.34       3.32         3.19       3.34       3.35         3.19       27.7       29.1         3.34       3.35       3.4         3.34 <t< th=""><th><math display="block"> \begin{array}{cccccccccccccccccccccccccccccccccccc</math></th><th><math display="block"> \begin{array}{cccccccccccccccccccccccccccccccccccc</math></th></t<>  | $ \begin{array}{cccccccccccccccccccccccccccccccccccc$  | $ \begin{array}{cccccccccccccccccccccccccccccccccccc$  
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| .86 2.45 2.8                                      | .29 0.41 0.47  | 21 25.3 24.1 |              | 2.61 178.82 254.       | 2.61         178.82         254.7           .24         3.18         5.0' | 2.61 178.82 254.7<br>.24 3.18 5.0 <sup>7</sup><br>.63 0.60 0.4 <sup>4</sup> | 2.61 178.82 254.7<br>24 3.18 5.07<br>.63 0.60 0.49<br>.91 0.94 0.90          | 2.61 178.82 254.7<br>24 3.18 5.07<br>.63 0.60 0.48<br>.91 0.94 0.94<br>.66 8.47 14.4             | 2.61 178.82 254.7<br>24 3.18 5.07<br>63 0.60 0.48<br>.91 0.94 0.90<br>.66 8.47 14.4<br>.28 3.22 5.70               | 2.61         178.82         254.7           24         3.18         5.07           63         0.60         0.48           91         0.94         0.90           .66         8.47         14.4           .28         3.22         5.70           .18         1.79         1.60  | 2.61         178.82         254.7           24         3.18         5.07           .63         0.60         0.48           .91         0.94         0.90           .66         8.47         14.4           .18         1.79         1.66           .18         1.79         1.66           .18         1.79         1.66  | 2.61     178.82     254.7       24     3.18     5.07       .63     0.60     0.48       .91     0.94     0.90       .66     8.47     14.4       .18     1.79     1.6       .18     1.79     1.6       .18     1.79     1.6       .59     36     28°  | 2.61     178.82     254.7       24     3.18     5.07       63     0.60     0.48       91     0.94     0.90       66     8.47     14.4       18     1.79     1.6       .18     1.79     1.6       .13     11.6     8.3       .13     11.6     8.3       .13     11.6     8.3       .13     11.6     1.6  | 2.61     178.82     254.3       24     3.18     5.07       23     0.60     0.48       91     0.94     0.90       66     8.47     14.4       28     3.22     5.70       28     3.22     5.71       18     1.79     1.60       1.3     11.6     8.3       5.9     36     28.3       5.9     36     28.3       21     4.75     4.11   | 2.61     178.82     254.7       24     3.18     5.07       23     0.60     0.48       91     0.94     0.90       28     3.22     5.77       28     3.22     5.77       18     1.79     1.66       1.3     11.6     8.3       5.9     36     28.2       5.9     36     28.2       21     4.75     4.11       5.8     6.96     4.56  | 2.61     178.82     254.7       24     3.18     5.07       291     0.94     0.90       91     0.94     0.90       .66     8.47     14.4       .18     1.79     1.6       .18     1.79     1.6       .13     11.6     8.3       .28.     3.22     5.7       .28     3.22     5.7       .13     11.6     8.3       .13     11.6     8.3       .29     3.6     2.8       .21     4.75     4.16       .21     4.75     4.16       .31     10.4     17.0  | 2.61     178.82     254.3       24     3.18     5.07       63     0.60     0.48       91     0.94     0.90       66     8.47     14.4       18     1.79     1.66       18     1.79     1.66       13     11.6     8.3       13     11.6     28.3       5.9     36     2.80       5.9     36     2.80       5.9     36     2.80       3.1     10.4     17.0       5.2     20     15.7   | $\begin{array}{cccccccccccccccccccccccccccccccccccc$  
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$\begin{array}{cccccccccccccccccccccccccccccccccccc$  | 2.601     178.82     254.7       2.4     3.18     5.07       91     0.94     0.96       66     8.47     14.4       66     8.47     14.4       1.8     1.79     1.60       1.8     1.79     1.60       5.9     3.6     2.81       5.9     3.6     2.81       5.9     3.6     2.81       5.9     3.6     4.50       5.1     10.4     17.6       5.2     20     15.7       5.8     6.96     4.50       5.1     10.4     17.6       5.2     20     15.7       8.8     450.4     6.88       8.8     450.4     6.88       8.8     450.4     6.88       31.8     132.6     184.       31.8     132.6     146.       31.8     132.6     146.       31.8     1.88     3.34.   | $\begin{array}{cccccccccccccccccccccccccccccccccccc$  | $\begin{array}{cccccccccccccccccccccccccccccccccccc$  
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| ()))<br>))))                                      | 0.46 0.29      | 31.4 21      | 736.71 157.6 | 0.701 17.007           | 3.59 3.24   | 3.59 3.24<br>0.50 0.62  | 0.50 0.63<br>0.50 0.63<br>0.96 0.90  | 0.50 0.63<br>0.50 0.63<br>0.96 0.91<br>0.95 0.91<br>0.95 0.91                                    | 9.325 0.63<br>9.50 0.63<br>0.96 0.91<br>9.35 9.66<br>5.10 3.28   | 9.254 0.50<br>9.50 0.63<br>0.50 0.63<br>0.91<br>9.35 9.66<br>5.10 3.28<br>1.45 2.18   | 0.50     0.50       3.59     3.24       0.50     0.63       0.91     0.91       9.35     9.66       5.10     3.26       1.45     2.18       8.5     11.3  | 2.201 1.2022<br>3.59 2.324<br>0.50 0.63<br>0.96 0.91<br>9.35 9.66<br>5.10 3.28<br>1.45 2.18<br>8.5 11.2<br>20.3 45.5  | 2.201<br>3.59<br>0.50<br>0.96<br>0.96<br>9.35<br>9.66<br>5.10<br>1.45<br>2.18<br>8.5<br>11.3<br>8.5<br>11.3<br>8.5<br>45.9<br>68.8  | 2.201<br>3.59<br>0.50<br>0.50<br>0.91<br>9.35<br>9.66<br>9.35<br>9.66<br>1.45<br>2.18<br>8.5<br>11.3<br>8.5<br>11.3<br>8.5<br>11.3<br>8.5<br>8.5<br>6.41<br>5.21<br>8.2  | 2.202       3.59       3.59       3.50       0.50       0.50       0.50       9.35       9.35       9.35       9.35       9.35       9.35       9.36       9.35       9.35       9.36       9.35       9.35       9.35       9.35       9.35       9.35       9.35       9.35       9.35       9.35       11.3       20.3       45.9       68.8       6.41       5.21       6.41       5.21       6.8       6.8       6.8       6.8  | 2.202       3.59       3.59       3.50       0.50       0.50       0.50       0.50       0.510       3.28       5.10       3.28       1.45       2.13       8.5       11.3       20.3       45.9       6.41       5.28       10.5       6.41       5.28       13.1   | 2.50     2.50       3.59     3.24       0.50     0.63       0.50     0.63       9.35     9.66       5.10     3.28       1.45     2.18       8.5     11.3       20.3     45.9       6.41     5.21       10.5     68.8       6.41     5.21       10.5     6.8       38.3     25.3       25.3     13.1  | 2.50     2.50       3.59     3.59       0.50     0.63       0.510     9.35       9.35     9.66       5.10     3.28       1.45     2.18       8.5     11.3       20.3     45.9       6.41     5.21       10.5     6.88       25.8     13.1       25.8     13.1       16.7     18.5       16.7     18.5       16.7     18.4   
   | 2.202       2.202       3.59       3.59       0.50       0.50       0.50       0.510       9.35       9.35       9.35       9.35       9.35       9.35       9.35       9.35       9.35       9.35       9.35       9.35       9.35       9.45   <   | 2.2021     2.2022       3.59     3.59     3.24       0.50     0.63     0.63       0.935     9.66     0.91       9.35     9.66     0.11.3       8.5     11.3     20.3     45.9       8.5     11.3     20.3     45.9       8.5     11.3     20.3     45.9       6.41     5.21     10.5     6.8       10.5     6.8     13.1       38.3     25.5     13.1       38.3     25.5     13.1       16.7     18.5     117.       174.7     117.     18.5       611.4     388     383  
   | 2.50     0.50     0.63       3.59     3.59     3.24       0.50     0.63     0.91       9.35     9.66     0.91       9.35     9.66     0.91       9.35     9.66     2.18       8.5     11.3     20.3       8.5     11.3     2.21       8.5     11.3     2.21       8.5     11.3     2.21       8.5     11.3     2.21       10.5     6.8     13.1       38.3     2.5.2     18.5       16.7     18.5     18.5       174.7     117     177       174.7     117     18.5       158.1     202     18.5       158.1     202     202   | 2.50     2.50       3.59     3.59       0.50     0.63       0.510     9.35       9.35     9.66       5.10     3.28       1.45     2.18       8.5     11.3       20.3     45.9       6.41     5.21       10.5     6.8       6.41     5.21       10.5     6.8       11.45     13.1       38.3     25.2       16.7     18.5       174.7     117.       611.4     388       158.1     202       158.1     202       158.1     202       158.1     202       158.1     202       158.1     202       15.5     14.4   | 2.50     2.50       3.59     3.59       0.50     0.63       0.510     9.35       9.35     9.66       5.10     3.28       1.45     2.18       8.5     11.3       20.3     45.9       6.41     5.21       10.5     6.8.8       6.41     5.21       10.5     6.8.8       13.1     25.8       16.7     18.5       16.7     18.5       174.7     117       611.4     388       158.1     202       158.1     202       158.1     202       158.1     202       15.5     1.4       15.5     1.4       15.5     1.4       15.5     1.4       17.2     1.4       17.2     1.4       1.12     1.4   | 2.202     
 2.202       3.59       3.59       0.50       0.50       0.510       9.35       9.35       9.35       9.35       9.35       9.35       9.35       9.35       9.35       9.35       9.35       9.35       9.35       9.45       9.35       9.45       9.35       9.45       10.5       117       118       117       118       118       118       118       117       118       118       117       118       1143       1143       1141   | $\begin{array}{cccccccccccccccccccccccccccccccccccc$   | 2.50     2.50       3.59     3.59       0.50     0.63       0.510     9.35       9.35     9.66       5.10     3.28       1.45     2.18       1.45     2.13       8.5     11.3       8.5     11.3       8.5     11.3       8.5     11.3       8.5     11.3       20.3     45.9       6.41     5.21       10.5     6.8       8.3     3.3       38.3     2.52       16.7     18.5       174.7     117.       16.7     18.5       174.7     117.       16.7     18.5       17.4     388       16.1     18.5       174.7     117.       175.1     18.5       18.5     1.31.       12.5     1.43       143.7     131.       2.69     1.36       2.69     1.36       2.78     1.36       2.69     1.36       2.78     1.37       2.78     1.37   | 2.2021     2.2021       3.59     3.59     3.24       0.50     0.63     0.63       0.510     9.35     9.66       5.10     3.28     9.66       8.5     11.3     2.18       1.45     2.18     11.3       8.5     11.3     2.52       10.5     6.8     6.8       10.5     6.8     13.1       10.5     18.5     13.1       11.4     383     25.2       16.7     18.5     13.1       174.7     117.     611.4       38.3     25.5     13.1       174.7     117.     13.1       175.1     1.85     1.34       175.1     1.45     1.34       2.69     1.31     2.69       143.7     1.31.     2.69       143.7     1.31.     2.69       143.7     1.31.     2.69       2.69     1.32     2.34       2.69     1.32     2.34       2.69     1.33     2.45       34.5     1.34  
   | 2.2021       3.59       3.59       0.50       0.50       0.50       0.51       9.35       9.35       9.35       9.35       9.35       9.35       9.35       9.35       9.35       9.35       9.35       9.35       9.35       9.35       9.35       9.45       9.36       9.37       9.38       10.5       6.41       5.23       45.9       68.8       63.3       45.9       68.8       10.5       6.8       10.5       6.8       117       174.7       174.7       172       174.7       172       18.5       143.7       131.4       2.69       1.72       2.45       1.72       2.45       1.72       2.45       1.72       1.72       1.72       1.72       2.45       1.72       2.45       1.72 </td <td>2.50     2.50       3.59     3.59       0.50     0.63       0.510     9.35       9.35     9.66       5.10     3.28       1.45     2.18       8.5     11.3       8.5     11.3       8.5     11.3       8.5     9.66       9.35     9.66       8.5     11.3       8.5     11.3       20.3     45.9       6.41     5.21       16.7     18.5       174.7     18.5       174.7     18.5       174.7     18.5       174.7     18.5       174.7     18.5       174.7     18.5       174.7     11.7       25.8     13.1       25.8     13.1       13.5     143.7       143.7     131.5       2.69     1.35       2.69     1.36       2.69     1.37       2.69     1.36       2.69     1.37       2.78     1.36       2.78     1.37       2.78     1.37       2.79     1.445       2.33     4.46</td> <td>2.202         2.202         3.59         3.59         3.59         3.59         9.35         9.35         9.35         9.35         9.35         9.35         9.35         9.35         9.35         9.35         9.35         9.45         9.45         9.45         9.5         11.45         20.3         45.9         6.41         5.2         10.5         6.41         5.2         10.5         6.41         5.2         16.7         174.7         117.         16.7         18.5         11.2         11.2         11.2         11.2         11.3         2.69         1.17         1.17         1.18.5         1.17         1.18.5         1.17         1.18.5         1.14.2         1.14.2     <!--</td--><td>2.50       2.021         3.59       3.59         3.59       3.24         9.35       9.35         9.35       9.35         9.35       9.35         9.35       9.66         5.10       3.28         1.45       5.13         8.5       11.3         8.5       11.3         8.5       11.3         8.5       11.3         8.5       11.3         8.641       5.21         8.7       6.8         6.41       5.21         10.5       6.8         8.33       25.2         16.7       18.5         16.7       18.5         16.7       18.5         174.7       117.         16.7       18.5         17.2       1.31.         2.69       1.36         2.69       1.36         2.46       1.31.         2.35       1.34         2.35       1.34         2.35       1.34         2.35       1.34         2.35       1.34         2.35       2.35         3.445</td></td> | 2.50     2.50       3.59     3.59       0.50     0.63       0.510     9.35       9.35     9.66       5.10     3.28       1.45     2.18       8.5     11.3       8.5     11.3       8.5     11.3       8.5     9.66       9.35     9.66       8.5     11.3       8.5     11.3       20.3     45.9       6.41     5.21       16.7     18.5       174.7     18.5       174.7     18.5       174.7     18.5       174.7     18.5       174.7     18.5       174.7     18.5       174.7     11.7       25.8     13.1       25.8     13.1       13.5     143.7       143.7     131.5       2.69     1.35       2.69     1.36       2.69     1.37       2.69     1.36       2.69     1.37       2.78     1.36       2.78     1.37       2.78     1.37       2.79     1.445       2.33     4.46   | 2.202         2.202         3.59         3.59         3.59         3.59         9.35         9.35         9.35         9.35         9.35         9.35         9.35         9.35         9.35         9.35         9.35         9.45         9.45         9.45         9.5         11.45         20.3         45.9         6.41         5.2         10.5         6.41         5.2         10.5         6.41         5.2         16.7         174.7         117.         16.7         18.5         11.2         11.2         11.2         11.2         11.3         2.69         1.17         1.17         1.18.5         1.17         1.18.5         1.17         1.18.5         1.14.2         1.14.2 </td <td>2.50       2.021         3.59       3.59         3.59       3.24         9.35       9.35         9.35       9.35         9.35       9.35         9.35       9.66         5.10       3.28         1.45       5.13         8.5       11.3         8.5       11.3         8.5       11.3         8.5       11.3         8.5       11.3         8.641       5.21         8.7       6.8         6.41       5.21         10.5       6.8         8.33       25.2         16.7       18.5         16.7       18.5         16.7       18.5         174.7       117.         16.7       18.5         17.2       1.31.         2.69       1.36         2.69       1.36         2.46       1.31.         2.35       1.34         2.35       1.34         2.35       1.34         2.35       1.34         2.35       1.34         2.35       2.35         3.445</td> | 2.50       2.021         3.59       3.59         3.59       3.24         9.35       9.35         9.35       9.35         9.35       9.35         9.35       9.66         5.10       3.28         1.45       5.13         8.5       11.3         8.5       11.3         8.5       11.3         8.5       11.3         8.5       11.3         8.641       5.21         8.7       6.8         6.41       5.21         10.5       6.8         8.33       25.2         16.7       18.5         16.7       18.5         16.7       18.5         174.7       117.         16.7       18.5         17.2       1.31.         2.69       1.36         2.69       1.36         2.46       1.31.         2.35       1.34         2.35       1.34         2.35       1.34         2.35       1.34         2.35       1.34         2.35       2.35         3.445   
  |
|   | 0.29           | 24.2         | 236.58       |                        | .EE 4.88  | .EE 4.88<br>0.52  | .EE 4.88<br>0.52<br>0.92   | .EE 4.88<br>0.52<br>0.92<br>N 15.65  | EE 4.88<br>0.52<br>n 15.65<br>N 6.42   | EE 4.88<br>0.52<br>0.92<br>h 15.65<br>h 6.42<br>1.88  | EE 4.88<br>0.52<br>0.92<br>N 15.65<br>N 1.88<br>9.8<br>9.8  | EE 4.88<br>0.52<br>0.92<br>N 15.65<br>0.8<br>N 6.42<br>0.8<br>1.88<br>9.8   | EE 4.88<br>0.52<br>0.92<br>0.92<br>0.92<br>0.8<br>0.42<br>0.8<br>1.88<br>9.8<br>16.2<br>41.5  | EE 4.88<br>0.52<br>0.92<br>N 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| EE 4.88<br>N 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6.42<br>9.8<br>9.8<br>16.2<br>14.6<br>6.14<br>14.6<br>31.9<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16.6<br>16. | <ul> <li>EE 4.88</li> <li>0.52</li> <li>0.92</li> <li>0.92</li> <li>0.92</li> <li>0.92</li> <li>0.92</li> <li>0.92</li> <li>15.65</li> <li>14.6</li> <li>14.6</li> <li>14.6</li> <li>14.6</li> <li>31.9</li> <li>16.2</li> <li>16.2</li> <li>16.2</li> <li>16.2</li> <li>16.2</li> <li>16.2</li> <li>16.2</li> <li>16.2</li> <li>16.2</li> </ul>   | <ul> <li>EE 4.88</li> <li>0.52</li> <li>0.92</li> <li>0.92</li> <li>0.92</li> <li>0.92</li> <li>0.92</li> <li>15.65</li> <li>41.5</li> <li>41.5</li> <li>6.14</li> <li>14.6</li> <li>14.6</li> <li>31.9</li> <li>31.9</li> <li>547.3</li> </ul>   
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| EE 4.88<br><sup>N</sup> 15.65<br><sup>N</sup> 15.65<br><sup>N</sup> 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| EE 4.88<br><sup>N</sup> 15.65<br><sup>N</sup> 15.65<br><sup>N</sup> 15.65<br><sup>N</sup> 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| <ul> <li>EE 4.88</li> <li>0.52</li> <li>0.92</li> <li>0.92</li> <li>0.92</li> <li>0.92</li> <li>0.92</li> <li>0.92</li> <li>15.65</li> <li>6.14</li> <li>16.2</li> <li>16.2</li> <li>16.2</li> <li>16.2</li> <li>16.2</li> <li>16.2</li> <li>16.2</li> <li>16.2</li> <li>16.2</li> <li>10.7</li> <li>2.04</li> </ul>  
   | <ul> <li>EE 4.88</li> <li>0.52</li> <li>0.92</li> <li>0.92</li> <li>0.92</li> <li>0.92</li> <li>0.92</li> <li>0.92</li> <li>15.65</li> <li>6.14</li> <li>16.2</li> <li>14.6</li> <li>14.6</li> <li>14.6</li> <li>31.9</li> <li>16.2</li> <li>16.2</li> <li>16.2</li> <li>157.5</li> <li>557.5</li> <li>557.3</li> <li>16.2</li> <li>16.2</li> <li>16.2</li> <li>16.2</li> <li>157.5</li> <li>25.6</li> <li>31.9</li> <li>16.2</li> <li>25.6</li> <li>31.9</li> <li>25.6</li> <li>31.9</li> <li>25.6</li> <li>31.9</li> <li>25.6</li> <li>31.9</li> <li>16.2</li> <li>157.5</li> <li>2.11</li> <li>10.7</li> <li>2.04</li> <li>38.3</li> </ul>  | EE 4.88<br><sup>N</sup> 15.65<br>0.92<br>0.92<br>0.92<br>0.92<br>0.92<br>0.42<br>15.65<br>0.14<br>14.6<br>0.14<br>14.6<br>0.14<br>14.6<br>14.6<br>14.6<br>15.75<br>5.47<br>15.75<br>15.75<br>25.6<br>15.75<br>25.6<br>15.75<br>25.6<br>15.75<br>25.6<br>15.75<br>25.6<br>15.75<br>25.6<br>15.75<br>25.6<br>15.75<br>25.6<br>15.75<br>25.6<br>15.75<br>25.6<br>15.75<br>25.6<br>15.75<br>25.6<br>15.75<br>25.6<br>15.75<br>25.6<br>15.75<br>25.6<br>15.75<br>25.6<br>15.75<br>25.6<br>15.75<br>25.6<br>15.75<br>25.6<br>15.75<br>25.6<br>15.75<br>25.6<br>15.75<br>25.6<br>15.75<br>25.6<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75<br>15.75  | EE 4.88<br><sup>N</sup> 15.65<br>0.52<br>0.92<br>0.92<br>0.92<br>0.92<br>0.92<br>0.14<br>16.2<br>14.6<br>0.14<br>14.6<br>0.14<br>14.6<br>25.6<br>15.7.5<br>15.7.5<br>547.3<br>16.2<br>15.7.5<br>25.6<br>0.14<br>14.6<br>25.6<br>0.12<br>16.2<br>15.7.5<br>25.6<br>0.14<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>17.7<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>17.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>17.2<br>16.2<br>17.2<br>16.2<br>17.2<br>16.2<br>17.2<br>16.2<br>17.2<br>16.2<br>17.2<br>16.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>1 | <ul> <li>EE 4.88</li> <li>0.52</li> <li>0.92</li> <li>0.92</li> <li>0.92</li> <li>0.92</li> <li>0.92</li> <li>0.92</li> <li>0.42</li> <li>15.65</li> <li>6.14</li> <li>16.2</li> <li>16.2</li> <li>16.2</li> <li>16.2</li> <li>10.7</li> <li>2.04</li> <li>38.3</li> <li>0.38</li> <li>0.38</li> <li>0.38</li> <li>0.38</li> </ul>   
   | EE 4.88<br>N 15.65<br>N 15.65<br>N 15.65<br>N 1.88<br>9.8<br>16.2<br>14.6<br>6.14<br>14.6<br>6.14<br>14.6<br>547.3<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>16.2<br>17.2<br>16.2<br>17.2<br>16.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2<br>17.2    |
|   | Lu             | 7 Y          | ΣREE         |                        |   | 8Eu   | brei brei brei brei brei brei brei brei                                      | 8Eu<br>8Eu<br>8Ce<br>(La/Yb) <sub>N</sub>  | δEu<br>δEu<br>δCe<br>(La/Yb) <sub>N</sub><br>(La/Sm) <sub>N</sub>  | 8Eu           8Eu           8Ce           8Ce | b     b       b     b       b     b       b     b       b     b       c     b       c     c       c     b       c     c       c     c       c     c       c     c       c     c       c     c       c     c       c     c       c     c       c     c       c     c   | 8Eu           8Eu           8Ce           8Ce | AEu         AEu           8Eu         8Eu           8Ce         8Ce           8Co         8Ce           8Co         8Ce           8Co         8Co           8Co | AEU         AEU           8Eu         8Eu           8Eu         8Ce           8Ce         (La/Yb) <sub>N</sub> 6Gd/Yb) <sub>N</sub> (Gd/Yb) <sub>N</sub> 1         Zn           Pb         Pb           Co         Pb           Co         Co  | 8Eu         8Eu           8Eu         8Eu           8Ce         8Ce           8Ce  | ABU         ABU           8Eu         8Eu           8Ce         8Ce           8Ce         8Ce           8Ce         8Ce           8Cu         8Cu           9Cu         1           1         Cu           1         Zn           23         Cr  | AEu         AEu           8Eu         8Eu           8Ce         8Ce           8Ce         8Ce           8Ce         8Ce           8Cu         8Cu           9Cu         1           1         23           23         Cr           90         Vi   | ABU         ABU           8Eu         8Eu           8Ce         8Ce           8Co         8Ce           8Co         8Ce           8Co         8Co           8Co   | ABU         ABU           8Eu         8Eu           8Ce         8Ce           8Cu         8Ce           8Cu         8Ce           8Cu         8Cu           8Cu         8r   | ABU         ABU           8Eu         8Eu  | 3Eu           8Eu           8Eu           8Ce  | Minimum         Control           8Eu         8Eu           8Ce         8Ce           8Ce         1           1         1           1         1           1         1           1         1           1         1           2         2           2         2           2         1           2         2           3         2           8         1           8         8           8         8           8         8           1         1           1         1           1         1           1         1           2         1           1         1           1         1           1         1           1         1           1         1           1         1   | ABU         ABU           8Eu         8Eu           8Ce         8Ce           8Cu         8Ce           8Cu         8Cu           8Cu  | ABU         ABU           8Eu         8Eu           8Eu         8Ce           8Ce         (La/Yb) <sub>N</sub> 8Cu         70           9Cu         80  | ABU         ABU           8Eu         8Eu           8Eu         8Eu           8Eu         8Ce           8Cu         1           1         1           1         1           1         2           1         1           1         2           1         2           1         2           1         2           1         2           1         2           2         3           2         3           2         3           3         3           3         3           3         3           3         3           3         3           3         3           3         3           3         3           3         3           3         3           3         3           3         3           3         3           4         1           5         3           6         1           7         1           8  | Mark 1     Mark 1       8Eu     8Eu       8Eu     <   | REu         REu           8Eu         8Eu           8Eu         8Eu           8Ce         8Ce           8Cu         1           1         1           1         1           1         2           1         1           1         2           1         1           1         2           1         2           1         2           1         2           2         2           2         3           2         2           2         3           1         2           1         2           8         8           8         8           8         8           8         8           8         8           8         8           8         8           8         8           8         8           8         8           8         8           8         8           8         8           8         8           8  | Ag<br>Ag<br>Ag<br>Ag<br>Ag<br>Ag<br>Ag<br>Ag<br>Ag<br>Ag  | $\begin{array}{c cccc} & & & & & & & & & & & & & & & & & $  | $\begin{array}{cccc} & & & & & & & & & & & & & & & & & $   | $\begin{array}{cccc} & & & & & & & & & & & & & & & & & $  |
|   | 21 0.21        | .79 13.67    | 56 0.73      | 12 0.00                | 14 000  | 02 0.01   | 02 0.01<br>02 0.01<br>39 0.37  | 02 0.01<br>39 0.37<br>04 1.93  | 22 0.00<br>02 0.01<br>39 0.37<br>04 1.93<br>24 3.24  | 02 0.01<br>39 0.37<br>04 1.93<br>24 3.24<br>09 3.09   | 39         0.37           39         0.37           04         1.93           224         3.24           09         3.09           05         0.05  | 52         6.00           39         0.37           04         1.93           24         3.24           09         3.09           05         0.05           05         0.05           55         0.53   | 1.2         0.01           39         0.37           04         1.93           224         3.24           09         3.09           05         0.05           06         3.09           05         0.05           55         0.53           59         99.61  | 22         0.01           33         0.37           04         1.93           04         1.93           09         3.24           3.24         3.24           09         3.09           05         0.05           05         0.05           25         99.61           27         1.26   | 22         0.01           03         0.37           04         1.93           05         0.37           06         1.93           07         0.37           08         0.37           09         0.05           55         0.05           57         0.05           33         0.53           30         2.42           33         2.42  | 24 0.37<br>04 1.93<br>04 1.93<br>09 3.09<br>05 0.05<br>55 0.53<br>39 9.61<br>1.26<br>39 2.42<br>39 2.42  | 22         0.01           39         0.37           04         1.93           24         3.24           09         3.09           05         0.05           06         3.09           07         0.05           08         0.05           09         1.93           55         0.05           57         0.53           309         9.61           1.26         3.99           39         2.42           39         2.42           39         2.42           3064.23         3.064.23  | 1.2         0.01           39         0.37           04         1.93           24         3.24           09         3.09           05         0.05           06         3.09           07         0.05           08         3.09           09         3.09           05         0.05           55         0.05           57         9.16           39         2.42           39       
 2.42           39         2.42           39         2.42           3064.23         3064.23           63         0.63  | 22     0.01       39     0.37       04     1.93       04     1.93       09     3.09       05     0.05       05     0.05       329     99.61       27     1.26       39     2.42       39     2.42       39     2.42       39     2.42       39     2.42       31     1.26       33     2.42       34     1.26       33     2.42       34     1.26       37     1.26       38     1.1       493.00     0.63   | 22         0.01           39         0.37           04         1.93           24         3.24           05         0.05           06         3.09           55         0.53           59         99.61           27         1.26           39         2.42           39         2.42           39         2.42           39         2.42           39         2.42           39         2.42           31         493.00           63         0.63           11         1.12           11         1.12           11         1.12   
   | 24     0.37       002     0.01       034     1.93       04     1.93       05     0.37       06     3.24       07     0.65       08     0.05       09.61     1.26       39     2.42       39     2.42       39     2.42       39     2.42       39     2.42       39     2.42       39     2.42       30     2.42       31     493.00       63     0.63       11     1.12       11     1.12       133     32.4  | 02     0.01       03     0.37       04     1.93       24     3.24       09     3.09       05     0.05       55     0.53       309     9.61       21     224       339     2.53       9.18     3064.23       38.11     493.00       63     0.63       11     1.12       11     1.12       33     32.4       53     32.42   | 39     0.37       39     0.37       04     1.93       24     3.24       09     3.09       05     0.05       06     3.09       07     0.05       08     3.09       09     3.09       01     1.26       39     2.42       39     2.42       9.18     3064.23       8.11     493.00       63     0.63       11     1.12       11     1.12       8.3     3.24       5.3     57.5       06     5.75   | 24    
0.37       00     0.37       01     1.93       02     0.37       03     0.37       03     0.37       04     1.93       05     0.53       55     0.53       55     0.53       32     9.18       33     2.42       39     2.42       39     2.42       39     2.42       39     2.42       39     2.42       39     2.42       31     1.26       63     0.63       11     1.12       11     1.12       11     1.12       11     1.12       11     1.12       13     32.4       5.3     5.75       66     5.77       89     19.2  | 24         0.01           39         0.37           04         1.93           05         0.37           06         1.93           07         0.37           08         0.37           09         3.09           05         0.05           06         3.09           07         0.05           08         0.05           39         2.42           9.18         3064.23           311         493.00           63         0.63           11         1.12           11         1.12           11         1.12           11         1.12           132         332.4           533         5.75           66         5.77           89         19.2           32         332.4  | 22         0.01           02         0.037           04         1.93           05         0.37           06         1.93           55         0.05           55         0.53           55         0.53           59         99.61           27         1.26           39         2.42           39         2.42           39         2.42           39         2.42           311         493.00           63         0.63           111         1.12           111         1.12           111         1.12           111         1.12           133         57.5           33         57.5           34         3.25           35         5.75           85         0.91   | 02     0.37       03     0.37       04     1.93       05     0.37       06     1.93       55     0.53       55     0.53       55     0.53       55     0.53       55     0.53       59     99.61       21     1.26       33     2.42       39     2.42       39     2.42       31     42       63     0.63       111     1.12       111     1.12       111     1.12       83     9.42       63     0.63       111     1.12       111     1.12       111     1.12       111     1.12       85     9.18       32.4     3.25       85     0.91       92     3.46  
   | 24     0.37       00     0.37       01     1.93       02     0.37       03     0.37       04     1.93       05     0.37       06     3.09       07     0.05       08     0.05       09     0.05       39     0.05       30     2.42       31     42       063     0.63       11     1.12       11     1.12       11     1.12       11     1.12       11     1.12       11     1.12       11     1.12       11     1.12       11     1.12       11     1.12       12     33       13     32.5       19.2     3.46       0.5     3.46       0.5     3.46  | 24     3.24       002     0.37       01     1.93       02     0.37       037     0.37       037     0.37       037     0.37       037     0.37       039     0.37       039     0.37       039     0.37       039     0.05       330     0.53       331     2.42       339     2.42       39     2.42       39     2.42       311     493.00       63     0.63       11     1.12       11     1.12       11     1.12       11     1.12       11     1.12       11     1.12       11     1.12       11     1.12       12     3.32       33     3.25       34     3.25       35     3.46       05     3.46       05     3.46       05     3.46       05     3.46  | 02     0.37       03     04       04     1.93       05     0.37       06     1.93       07     0.37       08     0.37       09     3.09       09     3.09       00     3.09       00     3.09       00     3.09       00     3.09       33     2.42       34     9.18       35     2.42       9.18     3064.23       363     0.63       11     1.12       11     1.12       11     1.12       11     1.12       11     1.12       12     3.24       33     3.24       33     3.25       34     0.63       33     3.25       85     0.91       02     3.46       05     3.46       06     3.46       07     3.46       0.5     3.46       0.5     3.46       0.5     3.46       0.5     3.46       0.67     0.67  | 24     3.0       00     0.37       01     1.93       02     0.37       03     0.37       04     1.93       05     0.37       06     3.09       07     0.05       08     0.05       09     3.09       193     0.63       11     1.26       11     1.12       11     1.12       11     1.12       11     1.12       11     1.12       11     1.12       11     1.12       11     1.12       11     1.12       11     1.12       11     1.12       11     1.12       11     1.12       11     1.12       11     1.12       11     1.12       11     1.12       11     1.12       11     1.12       12     3.25       13     3.25       19     3.25       19     3.25       19     3.25       19     3.25       19     3.25       19     3.25       19     3.25       20     3.46  
  |
|   | 0.21 0.2       | 13.94 13.    | 0.56 0.5     | 1.06 1.1               |   | 0.02 0.0  | 0.02 0.0<br>0.37 0.3   | 0.02 0.0<br>0.37 0.3<br>1.99 2.0   | 0.02 0.0<br>0.37 0.3<br>1.99 2.0<br>3.17 3.2   | 0.02 0.0<br>0.37 0.3<br>1.99 2.0<br>3.17 3.2<br>3.01 3.0  | 0.02 0.02<br>0.37 0.3<br>1.99 2.0<br>3.17 3.2<br>3.01 3.0<br>0.05 0.0   | 0.02 0.02 0.0<br>0.37 0.3<br>1.99 2.0<br>3.17 3.2<br>3.01 3.0<br>0.05 0.0<br>0.48 0.5   | 0.02 0.02 0.0<br>0.37 0.3<br>1.99 2.0<br>3.17 3.2<br>3.01 3.0<br>0.05 0.0<br>0.48 0.5<br>99.61 99.  | 0.02 0.02 0.0<br>0.37 0.3<br>3.17 3.2<br>3.01 3.0<br>0.05 0.0<br>0.48 0.5<br>99.61 99.1<br>1.20 1.2  | 0.02         0.02           0.37         0.37           0.37         0.3           1.99         2.0           3.17         3.2           3.01         3.0           3.05         0.05           0.48         0.5           0.48         0.5           0.48         0.5           0.48         0.5           2.32         2.32           2.32         2.32  | 0.02 0.02 0.0<br>0.37 0.3<br>1.99 2.0<br>3.17 3.2<br>3.01 3.0<br>0.48 0.5<br>99.61 99.1<br>1.20 1.2<br>2.32 2.3<br>3098.86 3039  | 0.02 0.02 0.0<br>0.37 0.3<br>1.99 2.0<br>3.17 3.2<br>3.01 3.0<br>0.05 0.0<br>0.48 0.5<br>99.61 99.<br>1.20 1.2<br>2.32 2.3<br>3098.86 3039<br>504.71 508   | 0.02 0.02 0.0<br>0.37 0.3<br>1.99 2.0<br>3.17 3.2<br>3.01 3.0<br>0.05 0.0<br>0.48 0.5<br>99.61 99.<br>1.20 1.2<br>2.32 2.3<br>3098.86 3039<br>504.71 508  
   | 0.02         0.02         0.0           0.37         0.3         0.3           1.99         2.0         1.99           3.17         3.2         3.1           3.01         3.01         3.0           0.05         0.05         0.0           0.48         0.5         99.61           99.61         99.1         1.2           1.20         1.2         1.2           2.33         3098.86         3039           504.71         508         0.61           0.61         0.61         0.6           0.61         0.6         1.1  | 0.02         0.02         0.03           0.37         0.37         0.3           1.99         2.0         3.17         3.2           3.17         3.2         3.0         0.05         0.0           0.05         0.05         0.05         0.0         99.61         99.51           99.61         99.53         2.33         2.33         2.33         3038         504.71         508         3039           504.71         508         0.61         0.6         0.6         0.6         0.6           1.15         1.14         0.61         0.6         0.4         0.4         0.6         0.4         0.6         0.6         0.6         0.6         0.6         0.6         0.6         0.6         0.4         0.6         0.4         0.6         0.4         0.6         0.4         0.6         0.4         0.6         0.4         0.4         0.6         0.4 <td>0.02         0.02         0.0           0.37         0.37         0.3           1.99         2.0         3.17         3.2           3.17         3.2         3.0         0.6           0.05         0.05         0.0         0.6           0.48         0.5         99.61         99.5           120         1.20         1.2         1.2           2.32         2.32         2.33         3098.86         3039           3098.86         3039         504.71         508         0.6           0.15         1.15         1.11         0.16         0.4           0.42         0.42         0.4         0.4         0.6           59.8         333         59.8         333         59.8         333</td> <td>0.02         0.02         0.0           0.37         0.3         0.3           1.99         2.0         3.17         3.2           3.17         3.2         3.0         3.0           3.01         3.01         3.0         0.5         0.0           0.48         0.5         0.0         0.5         0.0           99.61         99         1.20         1.22         1.23           1.20         1.20         1.22         2.32         2.33           3098.86         3039         3039         504.71         508           0.61         0.61         0.6         0.6         0.6           1.15         1.11         0.42         0.4         0.6           102         50.8         333         59.8         333           59.8         333         56         333         56</td> <td>0.02         0.02         0.0           0.37         0.3         0.3           1.99         2.0         3.17         3.2           3.17         3.2         3.0         3.0           3.01         3.01         3.0         0.5         99.61           99.61         99.7         1.20         1.22         1.23           99.61         99.61         99.2         2.33         3098.86         3039           504.71         508         3039         504.71         508         0.6         0.6           1.15         1.11         0.42         0.42         0.42         0.42         0.42         0.42         0.42         0.42         0.42         0.42         0.42         0.42         0.42         0.42         0.42         0.42         0.42         0.43         1.02         556.8         33.33         59.8         10.3         6.03         1.03         6.03         1.03         6.03         1.03         6.03         1.03         6.03         1.03         6.03         1.03         1.03         6.03         1.03         1.03         1.03         1.03         1.03         1.03         1.03         1.03         1.03         1.</td> <td>0.02         0.02         0.0           0.37         0.3         0.3           1.99         2.0         3.17         3.2           3.17         3.20         3.01         3.0           3.01         3.01         3.0         0.5         99.61           99.61         99         1.20         1.2         2.3           99.61         99         1.20         1.2         2.3           1120         1.2         2.3         3038.86         3033           504.71         508         3033         504.71         508           0.61         0.6         0.6         0.6         0.6           1.15         1.1         0.42         0.4         59.8           59.8         333         3333         102         56.0           10.3         6.0         10.3         6.0         333</td> <td>0.02         0.02         0.0           0.37         0.3         0.3           1.99         2.0         3.17         3.2           3.17         3.20         0.3         3.0           3.17         3.01         3.0         3.0           3.01         3.01         3.0         0.5           0.05         0.05         0.0         0.0           0.48         0.5         99.61         99.1           1.20         1.22         1.23         3.33           3.098.86         30398.86         3039         504.71           50.8         30398.86         3039         504.71         508           0.61         0.61         0.6         0.6         0.6           1.15         1.11         0.42         0.4         56.8         33.3           102         55.8         33.3         10         56.0         3.3         56.0         3.3           33.1         1.8         3.3         56.0         3.3         56.0         3.3</td> <td>0.02         0.02         0.0           0.37         0.3         0.3           1.99         2.0         3.17           3.17         3.2         3.2           3.01         3.01         3.0           0.05         0.05         0.0           0.048         0.5         99.61           99.61         99.7         1.2           1.20         1.2         2.3           3098.86         30398.86         3039           50.471         508         8.33           1.15         1.1         0.42           0.42         0.4         0.6           1.15         1.1         0.42           1.02         50.8         33.3           50.8         33.3         1.0           1.02         56.6         3.3           6.6         3.3         0.9           0.99         0.8         0.8</td> <td>0.02         0.02         0.03           0.37         0.37         0.3           1.99         2.0         3.17         3.2           3.17         3.2         3.01         3.0           3.01         3.01         3.0         9.6           99.61         99.7         0.3         99.6           99.61         99.7         1.2         1.2           1.20         1.20         1.2         2.32           3098.86         3039         3039         504.71           508         0.61         0.6         0.4           0.61         0.6         3.3         10.2           59.8         333.1         1.8         33.3.1  
        102         56.6         3.3         6.0           33.1         1.8         5.74         4.0           5.74         4.0         3.4         4.0</td> <td>0.02         0.02         0.03           0.37         0.37         0.3           1.99         3.17         3.2           3.17         3.2         3.01           3.01         3.01         3.0           0.05         0.05         0.0           0.48         0.5         99.61           99.61         99         1.2           1.20         1.20         1.2           2.32         2.32         2.33           3098.86         3039         3039           504.71         508         0.6           1.15         1.1.1         0.42           0.42         0.42         0.42           10.2         56.         10.4           59.8         33.3.1         1.8           50.9         0.99         0.8           5.74         4.0         0.8           0.85         0.4         4.0</td> <td>0.02         0.02         0.0           0.37         0.3         0.3           1.99         3.17         3.2           3.17         3.2         0.3           3.17         3.2         0.3           3.17         3.2         0.3           3.01         3.01         3.0           0.05         0.05         0.0           0.48         0.5         99.61           99.61         99         1.2           1.20         1.20         1.2           2.32         2.33         3098.86         3039           504.71         508         303         303           504.71         508         303         303           50.42         0.42         0.42         0.4           0.42         0.42         0.4         0.6           10.2         56.6         3.3         3.3           5.74         4.0         0.8         0.4           0.85         0.4         4.0         0.8           3.99         2.8         2.8         2.8</td> <td>0.02         0.02         0.0           0.37         0.3         0.3           1.99         3.17         3.2           3.17         3.2         0.3           3.17         3.01         3.0           3.17         3.2         0.3           3.17         3.2         0.2           0.05         0.05         0.0           0.48         0.5         99.61           1.20         1.20         1.2           1.12         1.2         2.3           2.323         3098.86         3039           504.71         508         0.6           0.61         0.6         0.6           0.61         0.6         0.4           0.61         0.6         0.4           0.65         3.3         3.3           102         56.6         3.3           5.74         4.0         0.8           0.85         0.4         0.6           0.86         0.6         0.8           0.86         0.6         0.6</td> <td>0.02         0.02         0.0           0.37         0.37         0.3           1.99         3.17         3.2           3.17         3.20         3.01           3.01         3.01         3.0           0.05         0.05         0.0           0.048         0.5         99.61           99.61         99         1.20           1.20         1.20         1.2           2.33         3098.86         3039           504.71         508         0.6           0.61         0.6         0.6           0.115         1.1         0.42           0.115         0.42         0.4           0.61         0.6         0.6           0.61         0.6         0.4           0.65         3.3         0.9           33.1         1.8         5.7           0.99         0.85         0.4           0.85         0.4         0.6           0.85         0.28         0.4           0.85         0.28         0.4           0.86         0.6         0.6</td> | 0.02         0.02         0.0           0.37         0.37         0.3           1.99         2.0         3.17         3.2           3.17         3.2         3.0         0.6           0.05         0.05         0.0         0.6           0.48         0.5         99.61         99.5           120         1.20         1.2         1.2           2.32         2.32         2.33         3098.86         3039           3098.86         3039         504.71         508         0.6           0.15         1.15         1.11         0.16         0.4           0.42         0.42         0.4         0.4         0.6           59.8         333         59.8         333         59.8         333   | 0.02         0.02         0.0           0.37         0.3         0.3           1.99         2.0         3.17         3.2           3.17         3.2         3.0         3.0           3.01         3.01         3.0         0.5         0.0           0.48         0.5         0.0         0.5         0.0           99.61         99         1.20         1.22         1.23           1.20         1.20         1.22         2.32         2.33           3098.86         3039         3039         504.71         508           0.61         0.61         0.6         0.6         0.6           1.15         1.11         0.42         0.4         0.6           102         50.8         333         59.8         333           59.8         333         56         333         56  | 0.02         0.02         0.0           0.37         0.3         0.3           1.99         2.0         3.17         3.2           3.17         3.2         3.0         3.0           3.01         3.01         3.0         0.5         99.61           99.61         99.7         1.20         1.22         1.23           99.61         99.61         99.2         2.33         3098.86         3039           504.71         508         3039         504.71         508         0.6         0.6           1.15         1.11         0.42         0.42         0.42         0.42         0.42         0.42         0.42         0.42         0.42         0.42         0.42         0.42         0.42         0.42         0.42         0.42         0.42         0.43         1.02         556.8         33.33         59.8         10.3         6.03         1.03         6.03         1.03         6.03         1.03         6.03         1.03         6.03         1.03         6.03         1.03         1.03         6.03         1.03         1.03         1.03         1.03         1.03         1.03         1.03         1.03         1.03         1.   | 0.02      
  0.02         0.0           0.37         0.3         0.3           1.99         2.0         3.17         3.2           3.17         3.20         3.01         3.0           3.01         3.01         3.0         0.5         99.61           99.61         99         1.20         1.2         2.3           99.61         99         1.20         1.2         2.3           1120         1.2         2.3         3038.86         3033           504.71         508         3033         504.71         508           0.61         0.6         0.6         0.6         0.6           1.15         1.1         0.42         0.4         59.8           59.8         333         3333         102         56.0           10.3         6.0         10.3         6.0         333   | 0.02         0.02         0.0           0.37         0.3         0.3           1.99         2.0         3.17         3.2           3.17         3.20         0.3         3.0           3.17         3.01         3.0         3.0           3.01         3.01         3.0         0.5           0.05         0.05         0.0         0.0           0.48         0.5         99.61         99.1           1.20         1.22         1.23         3.33           3.098.86         30398.86         3039         504.71           50.8         30398.86         3039         504.71         508           0.61         0.61         0.6         0.6         0.6           1.15         1.11         0.42         0.4         56.8         33.3           102         55.8         33.3         10         56.0         3.3         56.0         3.3           33.1         1.8         3.3         56.0         3.3         56.0         3.3  | 0.02         0.02         0.0           0.37         0.3         0.3           1.99         2.0         3.17           3.17         3.2         3.2           3.01         3.01         3.0           0.05         0.05         0.0           0.048         0.5         99.61           99.61         99.7         1.2           1.20         1.2         2.3           3098.86         30398.86         3039           50.471         508         8.33           1.15         1.1         0.42           0.42         0.4         0.6           1.15         1.1         0.42           1.02         50.8         33.3           50.8         33.3         1.0           1.02         56.6         3.3           6.6         3.3         0.9           0.99         0.8         0.8  | 0.02         0.02         0.03           0.37         0.37         0.3           1.99         2.0         3.17         3.2           3.17         3.2         3.01         3.0           3.01         3.01         3.0         9.6           99.61         99.7         0.3         99.6           99.61         99.7         1.2         1.2           1.20         1.20         1.2         2.32           3098.86         3039         3039         504.71           508         0.61         0.6         0.4           0.61         0.6         3.3         10.2           59.8         333.1         1.8         33.3.1           102         56.6         3.3         6.0           33.1         1.8         5.74         4.0           5.74         4.0         3.4         4.0   
   | 0.02         0.02         0.03           0.37         0.37         0.3           1.99         3.17         3.2           3.17         3.2         3.01           3.01         3.01         3.0           0.05         0.05         0.0           0.48         0.5         99.61           99.61         99         1.2           1.20         1.20         1.2           2.32         2.32         2.33           3098.86         3039         3039           504.71         508         0.6           1.15         1.1.1         0.42           0.42         0.42         0.42           10.2         56.         10.4           59.8         33.3.1         1.8           50.9         0.99         0.8           5.74         4.0         0.8           0.85         0.4         4.0   | 0.02         0.02         0.0           0.37         0.3         0.3           1.99         3.17         3.2           3.17         3.2         0.3           3.17         3.2         0.3           3.17         3.2         0.3           3.01         3.01         3.0           0.05         0.05         0.0           0.48         0.5         99.61           99.61         99         1.2           1.20         1.20         1.2           2.32         2.33         3098.86         3039           504.71         508         303         303           504.71         508         303         303           50.42         0.42         0.42         0.4           0.42         0.42         0.4         0.6           10.2         56.6         3.3         3.3           5.74         4.0         0.8         0.4           0.85         0.4         4.0         0.8           3.99         2.8         2.8         2.8   | 0.02         0.02         0.0           0.37         0.3         0.3           1.99         3.17         3.2           3.17         3.2         0.3           3.17         3.01         3.0           3.17         3.2         0.3           3.17         3.2         0.2           0.05         0.05         0.0           0.48         0.5         99.61           1.20         1.20         1.2           1.12         1.2         2.3           2.323         3098.86         3039           504.71         508         0.6           0.61         0.6         0.6           0.61         0.6         0.4           0.61         0.6         0.4           0.65         3.3         3.3           102         56.6         3.3           5.74         4.0         0.8           0.85         0.4         0.6           0.86         0.6         0.8           0.86         0.6         0.6   | 0.02         0.02         0.0           0.37         0.37         0.3           1.99         3.17         3.2           3.17         3.20         3.01           3.01         3.01         3.0           0.05         0.05         0.0           0.048         0.5         99.61           99.61         99         1.20           1.20         1.20         1.2           2.33         3098.86         3039           504.71         508         0.6           0.61         0.6         0.6           0.115         1.1         0.42           0.115         0.42         0.4           0.61         0.6         0.6           0.61         0.6         0.4           0.65         3.3         0.9           33.1         1.8         5.7           0.99         0.85         0.4           0.85         0.4         0.6           0.85         0.28         0.4           0.85         0.28         0.4           0.86         0.6         0.6   
  |
|   | 0.35           | 14.09        | 0.59         | 2.74                   |   | 0.05  | 0.05<br>0.52   | 0.05<br>0.52<br>1.69   | 0.05<br>0.52<br>1.69<br>2.65   | 0.05<br>0.52<br>1.69<br>2.65<br>3.64  | 0.05<br>0.52<br>1.69<br>2.65<br>3.64<br>0.12  | 0.05<br>0.52<br>1.69<br>2.65<br>3.64<br>0.12<br>1.35  | 0.05<br>0.52<br>1.69<br>2.65<br>3.64<br>0.12<br>1.35<br>99.28   | 0.05<br>0.52<br>1.69<br>2.65<br>3.64<br>0.12<br>1.35<br>99.28<br>1.39  | 0.05<br>0.52<br>0.52<br>2.65<br>3.64<br>0.12<br>1.35<br>99.28<br>1.39<br>2.01  | 0.05<br>0.52<br>1.69<br>2.65<br>3.64<br>0.12<br>1.35<br>99.28<br>1.39<br>2.01<br>2.01  | 0.05<br>0.52<br>1.69<br>2.65<br>3.64<br>0.12<br>1.35<br>99.28<br>1.39<br>99.28<br>1.39<br>2.01<br>2.01<br>2.83.00<br>5   | 0.05<br>0.52<br>1.69<br>1.69<br>2.65<br>3.64<br>0.12<br>1.35<br>99.28<br>1.39<br>2.01<br>2.868.44<br>3'<br>0.59<br>0.59   
   | 0.05<br>0.52<br>1.69<br>2.65<br>3.64<br>0.12<br>1.35<br>99.28<br>1.39<br>1.39<br>1.39<br>2.01<br>2.01<br>883.44<br>30<br>0.59<br>0.59<br>1.24  | 0.05<br>0.52<br>1.69<br>2.65<br>3.64<br>0.12<br>1.35<br>99.28<br>99.28<br>1.39<br>2.01<br>2.01<br>2.01<br>0.59<br>0.59<br>0.59<br>0.28   
   | 0.05<br>0.52<br>1.69<br>2.65<br>3.64<br>0.12<br>1.35<br>99.28<br>1.39<br>2.01<br>2.01<br>2.01<br>0.59<br>0.59<br>0.28<br>0.28<br>30.7  | 0.05<br>0.52<br>1.69<br>2.65<br>3.64<br>0.12<br>1.39<br>99.28<br>1.39<br>2.01<br>2.01<br>2.01<br>2.69<br>0.59<br>0.59<br>0.28<br>30.7<br>62.9   | 0.05<br>0.52<br>1.69<br>2.65<br>3.64<br>0.12<br>1.35<br>99.28<br>1.39<br>2.01<br>1.39<br>2.01<br>1.24<br>0.59<br>0.59<br>0.59<br>1.24<br>0.59<br>0.59<br>1.24<br>30.7<br>30.7<br>7.63  |
0.05<br>0.52<br>1.69<br>2.65<br>3.64<br>0.12<br>1.35<br>99.28<br>1.39<br>1.39<br>1.39<br>2.01<br>1.24<br>0.59<br>0.59<br>0.59<br>0.59<br>0.59<br>0.59<br>2.01<br>1.24<br>2.01<br>7.63<br>30.7<br>2.57.7   | 0.05<br>0.52<br>1.69<br>2.65<br>3.64<br>0.12<br>1.35<br>99.28<br>1.39<br>1.39<br>1.39<br>1.39<br>2.01<br>883.44<br>30.7<br>0.59<br>0.59<br>0.59<br>0.28<br>0.28<br>0.28<br>0.28<br>0.28<br>30.7<br>6.2.9<br>6.2.9<br>6.2.9   | 0.05<br>0.52<br>1.69<br>1.69<br>3.64<br>0.12<br>1.35<br>99.28<br>1.39<br>1.39<br>1.39<br>2.01<br>0.59<br>0.59<br>0.59<br>0.59<br>0.59<br>0.59<br>0.59<br>1.24<br>1.24<br>1.24<br>1.24<br>1.24<br>1.24<br>1.24<br>1.24   | 0.05<br>0.52<br>1.69<br>1.69<br>3.64<br>0.12<br>1.35<br>99.28<br>483.00<br>5.01<br>0.59<br>0.59<br>0.59<br>0.59<br>0.59<br>0.59<br>0.59<br>0.59   
  | 0.05<br>0.52<br>1.69<br>1.69<br>3.64<br>0.12<br>1.35<br>99.28<br>483.00<br>0.59<br>0.59<br>0.28<br>0.28<br>0.28<br>0.28<br>0.28<br>0.28<br>0.28<br>0.28   | 0.05<br>0.52<br>0.52<br>1.69<br>2.65<br>3.64<br>0.12<br>1.39<br>99.28<br>1.39<br>2.01<br>2.868.44<br>30.7<br>2.868.44<br>3.0.7<br>2.868.44<br>3.0.7<br>2.59<br>0.59<br>0.59<br>1.24<br>1.24<br>0.59<br>5.42<br>6.29<br>6.29<br>6.29<br>0.58<br>3.0.7<br>1.44<br>1.44  | 0.05<br>0.52<br>0.52<br>1.69<br>2.65<br>3.64<br>0.12<br>1.39<br>99.28<br>1.39<br>2.01<br>2.868.44<br>30.7<br>2.868.44<br>30.7<br>2.868.44<br>30.7<br>6.2.9<br>6.2.9<br>6.2.9<br>6.2.9<br>6.2.9<br>6.2.9<br>0.542<br>0.542<br>0.542<br>0.542<br>0.542<br>0.542<br>0.542<br>0.542<br>0.542<br>0.542<br>0.542<br>0.542<br>0.542<br>0.542<br>0.542<br>0.542<br>0.542<br>0.542<br>0.542<br>0.542<br>0.542<br>0.542<br>0.542<br>0.542<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.5   | $\begin{array}{cccccccccccccccccccccccccccccccccccc$  
   |
|   | 0.35           | 13.48        | 0.87         | 2.27                   | 0.04  | 10.0  | 0.63   | 0.63<br>2.18   | 0.63<br>2.18<br>2.63   | 0.63<br>0.63<br>2.18<br>2.63<br>2.96  | 2.18<br>2.18<br>2.63<br>2.96<br>0.11  | 2.18<br>2.18<br>2.63<br>2.96<br>0.11<br>0.78  | 2.07<br>2.18<br>2.63<br>2.96<br>0.11<br>0.78<br>99.53   | 0.63<br>2.18<br>2.63<br>2.96<br>0.11<br>0.78<br>99.53  | 2.04<br>2.18<br>2.63<br>2.96<br>0.11<br>0.78<br>99.53<br>1.03<br>2.01  | 2.04<br>2.18<br>2.63<br>2.96<br>0.11<br>0.78<br>99.53<br>1.03<br>2.01<br>3156.19   | 2.18<br>2.18<br>2.63<br>2.96<br>0.11<br>0.78<br>99.53<br>1.03<br>2.01<br>3156.19<br>528.92   | 0.63<br>2.18<br>2.63<br>2.96<br>0.11<br>0.78<br>99.53<br>1.03<br>2.01<br>3156.19<br>528.92<br>0.56  
   | 0.63<br>2.18<br>2.63<br>2.96<br>0.11<br>0.78<br>99.53<br>1.03<br>2.01<br>3156.19<br>528.92<br>0.56   | 0.63<br>2.18<br>2.63<br>2.96<br>0.11<br>0.78<br>99.53<br>1.03<br>2.01<br>3156.19<br>528.92<br>0.56<br>1.17<br>0.36   
   | 2.13<br>2.18<br>2.63<br>2.96<br>0.11<br>0.78<br>99.53<br>1.03<br>2.01<br>3156.19<br>528.92<br>0.36<br>0.36<br>0.36<br>2.65   | 2.18<br>2.18<br>2.63<br>2.96<br>0.11<br>0.78<br>99.53<br>1.03<br>1.03<br>2.01<br>3156.19<br>528.92<br>0.56<br>0.56<br>0.56<br>0.36<br>0.36<br>2.26.6  | 2.18<br>2.18<br>2.63<br>2.96<br>0.11<br>0.78<br>99.53<br>1.03<br>1.03<br>2.01<br>3156.19<br>5.28.92<br>0.56<br>1.17<br>0.56<br>1.17<br>0.56<br>0.56<br>2.66<br>5.2.6   |
2.13<br>2.18<br>2.63<br>2.96<br>0.11<br>0.78<br>99.53<br>1.03<br>2.01<br>3156.19<br>528.92<br>0.56<br>1.17<br>0.56<br>1.17<br>0.56<br>0.56<br>2.66<br>52.6<br>52.6<br>52.6  | 2.18<br>2.63<br>2.63<br>2.96<br>0.11<br>0.78<br>99.53<br>1.03<br>2.01<br>3156.19<br>5.28.92<br>0.56<br>1.17<br>0.56<br>1.17<br>0.56<br>0.56<br>5.26<br>5.26<br>5.1<br>5.1  | 2.18<br>2.63<br>2.63<br>2.96<br>0.11<br>0.78<br>99.53<br>1.03<br>2.01<br>3156.19<br>5.28.92<br>0.56<br>1.17<br>0.36<br>5.28.92<br>0.36<br>5.26<br>5.26<br>5.1<br>5.1<br>1.05  | 2.18<br>2.63<br>2.63<br>2.96<br>0.11<br>0.78<br>99.53<br>1.03<br>2.01<br>3156.19<br>5.28.92<br>0.56<br>1.17<br>0.36<br>5.28.92<br>0.36<br>5.28.92<br>0.36<br>5.1<br>1.05<br>5.1<br>5.1<br>5.01  
  | 2.18<br>2.63<br>2.96<br>0.11<br>0.11<br>0.78<br>99.53<br>1.03<br>2.01<br>3156.19<br>5.28.92<br>0.56<br>1.17<br>0.36<br>5.26<br>6.57<br>5.1<br>1.05<br>5.1<br>1.05<br>5.01<br>5.01   | 2.18<br>2.18<br>2.63<br>2.96<br>0.11<br>0.78<br>99.53<br>1.03<br>2.01<br>3156.19<br>5.28.92<br>0.56<br>0.56<br>5.1<br>1.17<br>0.36<br>5.28.92<br>0.56<br>5.1<br>1.05<br>5.1<br>1.05<br>5.01<br>1.05   | 2.18<br>2.18<br>2.18<br>2.96<br>0.11<br>0.78<br>99.53<br>1.03<br>2.01<br>3156.19<br>5.28.92<br>0.56<br>1.17<br>0.56<br>1.17<br>0.56<br>5.28.92<br>0.56<br>5.28.92<br>0.56<br>5.1<br>1.05<br>5.1<br>1.05<br>5.01<br>0.65<br>7.8<br>0.36<br>0.36<br>0.36<br>0.36<br>0.36<br>0.36<br>0.36<br>0.36   | 2.18<br>2.18<br>2.18<br>2.96<br>0.11<br>0.78<br>99.53<br>1.03<br>2.01<br>1.03<br>5.28.92<br>0.56<br>5.26<br>5.26<br>5.26<br>5.26<br>5.26<br>5.1<br>1.05<br>5.1<br>1.05<br>5.01<br>0.65<br>7<br>5.01<br>0.65<br>1.05<br>1.05<br>1.05<br>1.05<br>1.05<br>1.05<br>1.05<br>1.0  
   |
|   | 0.44           | 14.22        | 0.89         | 2.77                   | 0.07  | 10.0  | 1.09   | 1.09<br>2.97   | 2.97<br>2.91<br>2.91   | 2.97<br>2.97<br>2.91<br>4.06  | 2.97<br>1.09<br>2.91<br>4.06<br>0.08  | 2.97<br>2.97<br>2.91<br>4.06<br>0.08<br>0.73  | 2.97<br>2.91<br>2.91<br>4.06<br>0.08<br>0.73<br>99.56   | 0.07<br>2.97<br>2.91<br>4.06<br>0.08<br>0.73<br>99.56<br>1.85  | 2.97<br>2.91<br>2.91<br>4.06<br>0.08<br>0.73<br>99.56<br>1.85<br>2.02  | 2.97<br>2.97<br>2.91<br>4.06<br>0.08<br>0.73<br>99.56<br>1.85<br>2.02<br>2.02  | 2.97<br>2.97<br>2.91<br>4.06<br>0.08<br>0.73<br>99.56<br>1.85<br>2.02<br>2.02<br>2.02<br>650.79  | 2.97<br>2.97<br>2.91<br>4.06<br>0.08<br>0.73<br>99.56<br>1.85<br>2.02<br>2.02<br>2.02<br>2.02<br>2.02<br>0.65   
   | 0.07<br>2.97<br>2.91<br>4.06<br>0.08<br>0.73<br>99.56<br>1.85<br>2.02<br>2.02<br>2.02<br>650.79<br>0.65<br>0.98  | 0.5%<br>0.0%<br>0.08<br>0.08<br>0.73<br>0.73<br>0.73<br>0.73<br>0.73<br>0.73<br>0.73<br>0.73<br>0.73<br>0.73<br>0.73<br>0.73<br>0.73<br>0.73<br>0.73<br>0.73<br>0.73<br>0.73<br>0.73<br>0.73<br>0.73<br>0.73<br>0.73<br>0.73<br>0.73<br>0.73<br>0.73<br>0.73<br>0.73<br>0.73<br>0.73<br>0.73<br>0.73<br>0.73<br>0.73<br>0.73<br>0.73<br>0.73<br>0.73<br>0.73<br>0.73<br>0.73<br>0.73<br>0.73<br>0.73<br>0.73<br>0.73<br>0.73<br>0.73<br>0.73<br>0.73<br>0.73<br>0.73<br>0.73<br>0.73<br>0.73<br>0.73<br>0.73<br>0.73<br>0.73<br>0.73<br>0.73<br>0.73<br>0.73<br>0.73<br>0.73<br>0.73<br>0.73<br>0.73<br>0.73<br>0.73<br>0.73<br>0.73<br>0.73<br>0.73<br>0.73<br>0.73<br>0.73<br>0.73<br>0.73<br>0.73<br>0.73<br>0.75<br>0.75<br>0.75<br>0.76<br>0.79<br>0.79<br>0.79<br>0.79<br>0.79<br>0.79<br>0.79<br>0.79<br>0.79<br>0.79<br>0.79<br>0.79<br>0.79<br>0.79<br>0.79<br>0.79<br>0.79<br>0.79<br>0.79<br>0.79<br>0.79<br>0.79<br>0.79<br>0.79<br>0.79<br>0.79<br>0.79<br>0.79<br>0.79<br>0.79<br>0.79<br>0.79<br>0.79<br>0.79<br>0.79<br>0.79<br>0.79<br>0.79<br>0.79<br>0.79<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0.58<br>0  
   | 2.97<br>2.97<br>2.91<br>4.06<br>0.08<br>0.73<br>99.56<br>1.85<br>2.02<br>2.02<br>2.02<br>2.53.51<br>650.79<br>0.65<br>0.98<br>0.53   | 2.97<br>2.97<br>2.91<br>4.06<br>0.08<br>0.73<br>99.56<br>1.85<br>2.02<br>2.02<br>2.02<br>2.53<br>0.65<br>0.98<br>0.53<br>0.53<br>89.1   | 2.97<br>2.91<br>2.91<br>4.06<br>0.08<br>0.73<br>99.56<br>1.85<br>2.02<br>2.02<br>2.02<br>2.02<br>2.02<br>0.65<br>0.98<br>0.65<br>0.98<br>0.53<br>0.53<br>0.53  |
2.97<br>2.91<br>2.91<br>4.06<br>0.08<br>0.73<br>99.56<br>1.85<br>2.02<br>2.02<br>2.02<br>650.79<br>0.53<br>0.53<br>0.53<br>1.65<br>0.53<br>0.53<br>8.9.1<br>8.9.1<br>8.9.1<br>8.9.1<br>8.9.1<br>8.9.1<br>8.9.1<br>8.9.1<br>8.9.1<br>8.9.1<br>8.9.1<br>8.9.1<br>8.9.1<br>8.9.1<br>8.9.1<br>8.9.1<br>8.9.1<br>8.9.1<br>8.9.1<br>8.9.1<br>8.9.1<br>8.9.1<br>8.9.1<br>8.9.1<br>8.9.1<br>8.9.1<br>8.9.2<br>8.9.1<br>8.9.2<br>8.9.2<br>8.9.2<br>8.9.2<br>8.9.2<br>8.9.2<br>8.9.2<br>8.9.2<br>8.02<br>8.02<br>8.02<br>8.02<br>8.02<br>8.02<br>8.02<br>8.   | 0.07<br>2.97<br>2.91<br>4.06<br>0.08<br>0.73<br>99.56<br>1.85<br>2.02<br>2.02<br>2.02<br>2.02<br>0.65<br>0.53<br>0.53<br>4.6.1<br>8.9.1<br>8.9.1<br>8.9.1<br>8.9.1<br>8.5.0<br>9.27<br>33.6<br>5.69  | 0.07<br>2.97<br>2.91<br>4.06<br>0.08<br>0.73<br>99.56<br>1.85<br>2.02<br>2.02<br>2.02<br>2.02<br>0.65<br>0.98<br>0.53<br>0.53<br>0.53<br>0.53<br>0.53<br>0.53<br>0.53<br>0.53<br>0.53<br>0.53<br>0.53<br>0.53<br>0.53<br>0.53<br>0.53<br>0.56<br>0.98<br>0.56<br>0.98<br>0.56<br>0.98<br>0.56<br>0.98<br>0.56<br>0.98<br>0.56<br>0.73<br>0.56<br>0.73<br>0.73<br>0.56<br>0.73<br>0.73<br>0.73<br>0.73<br>0.73<br>0.73<br>0.73<br>0.73<br>0.73<br>0.73<br>0.73<br>0.73<br>0.73<br>0.73<br>0.73<br>0.73<br>0.73<br>0.73<br>0.73<br>0.73<br>0.73<br>0.73<br>0.73<br>0.73<br>0.73<br>0.73<br>0.75<br>0.75<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56<br>0.56 | 2.97<br>2.91<br>2.91<br>4.06<br>0.08<br>0.73<br>99.56<br>1.85<br>2.02<br>2.53.51<br>650.79<br>0.65<br>0.98<br>0.53<br>4.61<br>8.9.1<br>8.9.1<br>8.9.1<br>8.9.1<br>8.9.1<br>8.9.1<br>8.5.69<br>0.96<br>5.69  
  | 2.97<br>2.97<br>2.91<br>4.06<br>0.08<br>0.73<br>99.56<br>1.85<br>2.02<br>2.523.51<br>650.79<br>0.65<br>0.98<br>0.53<br>4.6.1<br>8.9.1<br>8.9.1<br>8.9.1<br>8.9.1<br>8.9.1<br>8.9.1<br>8.9.1<br>8.9.2<br>0.98<br>0.53<br>0.98<br>0.98<br>0.98<br>0.92<br>0.98<br>0.92<br>0.98<br>0.92<br>0.96<br>0.98<br>0.92<br>0.98<br>0.92<br>0.98<br>0.92<br>0.98<br>0.92<br>0.98<br>0.92<br>0.98<br>0.98<br>0.98<br>0.98<br>0.98<br>0.98<br>0.98<br>0.98  | 2.97<br>2.97<br>2.91<br>4.06<br>0.08<br>0.73<br>99.56<br>1.85<br>2.02<br>2.53.51<br>650.79<br>0.65<br>0.98<br>0.53<br>0.98<br>0.53<br>0.98<br>0.53<br>0.98<br>0.53<br>0.53<br>0.98<br>0.53<br>0.98<br>0.53<br>0.98<br>0.53<br>2.59<br>5.69<br>0.72<br>5.95  | 2.97<br>2.91<br>2.91<br>4.06<br>0.08<br>0.73<br>99.56<br>1.85<br>2.02<br>2.02<br>2.02<br>0.65<br>0.98<br>0.53<br>0.53<br>0.53<br>0.53<br>0.53<br>0.53<br>0.53<br>0.53  |
0.05<br>2.97<br>2.91<br>2.91<br>4.06<br>0.73<br>99.56<br>0.73<br>9.56<br>0.98<br>0.53<br>1.85<br>0.73<br>0.65<br>0.98<br>0.53<br>0.53<br>0.53<br>0.53<br>0.53<br>0.53<br>0.53<br>0.53<br>0.53<br>0.53<br>0.53<br>0.53<br>0.53<br>0.53<br>0.53<br>0.53<br>0.53<br>0.53<br>0.53<br>0.53<br>0.53<br>0.53<br>0.53<br>0.53<br>0.53<br>0.53<br>0.53<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55<br>0.55 |
|   | 0.34           | 14.01        | 0.73         | 2.35                   |   | 0.06  | 0.06<br>1.12   | 0.06<br>1.12<br>2.28   | 0.06<br>1.12<br>2.28<br>2.58   | 0.06<br>1.12<br>2.28<br>2.58<br>4.30  | 0.06<br>1.12<br>2.28<br>2.58<br>4.30<br>0.06  | 0.06<br>1.12<br>2.28<br>4.30<br>0.06<br>0.87  | 0.06<br>1.12<br>2.28<br>2.58<br>4.30<br>0.06<br>0.87<br>99.77   | 0.06<br>1.12<br>2.28<br>2.58<br>4.30<br>0.06<br>0.87<br>99.77<br>1.69  | 0.06<br>1.12<br>2.28<br>2.58<br>0.06<br>0.87<br>0.87<br>0.87<br>1.69<br>1.93   | 0.06<br>1.12<br>2.28<br>4.30<br>0.87<br>0.87<br>99.77<br>1.69<br>1.93<br>2718.71   | 0.06<br>1.12<br>2.28<br>2.58<br>4.30<br>0.06<br>0.87<br>99.77<br>1.69<br>1.93<br>2718.71<br>574.33   | 0.06<br>1.12<br>2.28<br>2.58<br>4.30<br>0.06<br>0.87<br>0.87<br>0.87<br>1.69<br>1.69<br>1.93<br>2718.71<br>574.33<br>0.64   
   | 0.06<br>1.12<br>2.28<br>2.58<br>4.30<br>0.06<br>0.87<br>99.77<br>99.77<br>1.69<br>1.93<br>574.33<br>0.64<br>1.07   | 0.06<br>1.12<br>2.28<br>2.58<br>4.30<br>0.06<br>0.87<br>0.87<br>0.87<br>1.93<br>574.33<br>0.64<br>1.07<br>0.64   
   | 0.06<br>1.12<br>2.28<br>2.58<br>4.30<br>0.06<br>0.87<br>0.87<br>0.87<br>0.87<br>0.87<br>0.64<br>1.07<br>0.64<br>0.65<br>5.2.8  | 0.06<br>1.12<br>2.28<br>2.58<br>4.30<br>0.06<br>0.87<br>99.77<br>1.69<br>1.93<br>2718.71<br>574.33<br>0.64<br>1.07<br>0.65<br>52.8<br>94.6  | 0.06<br>1.12<br>2.28<br>2.58<br>4.30<br>0.06<br>0.87<br>0.87<br>0.87<br>0.87<br>0.87<br>0.87<br>0.64<br>1.07<br>0.64<br>0.65<br>52.8<br>94.6<br>94.6<br>94.6   |
0.06<br>1.12<br>2.28<br>2.58<br>4.30<br>0.06<br>0.87<br>0.87<br>1.93<br>0.64<br>1.07<br>0.64<br>1.07<br>0.64<br>0.65<br>574.33<br>0.65<br>574.33<br>0.65<br>9.76<br>9.76<br>33.1  | 0.06<br>1.12<br>2.28<br>2.58<br>4.30<br>0.06<br>0.87<br>0.87<br>1.93<br>574.33<br>0.64<br>1.07<br>0.64<br>1.07<br>0.64<br>1.07<br>0.65<br>574.33<br>0.65<br>574.33<br>574.33<br>574.33<br>574.33<br>574.33<br>574.33<br>574.33<br>574.33<br>574.33<br>574.33<br>574.33<br>574.33<br>574.33<br>574.33<br>574.33<br>576<br>576<br>578<br>578<br>578<br>578<br>578<br>578<br>578<br>578<br>578<br>578   | 0.06<br>1.12<br>2.28<br>2.58<br>4.30<br>0.06<br>0.87<br>0.87<br>1.93<br>1.93<br>0.64<br>1.07<br>0.64<br>1.07<br>0.64<br>1.07<br>0.64<br>1.07<br>0.65<br>574.33<br>0.64<br>1.07<br>0.65<br>574.33<br>0.65<br>57.8<br>33.1<br>0.9   | 0.06<br>1.12<br>2.28<br>2.58<br>4.30<br>0.06<br>0.87<br>0.87<br>1.93<br>1.93<br>0.64<br>1.07<br>0.64<br>1.07<br>0.64<br>1.07<br>0.64<br>1.07<br>0.65<br>5.2.8<br>5.18<br>0.9<br>5.18<br>5.3   
  | 0.06<br>1.12<br>2.28<br>2.58<br>4.30<br>0.06<br>0.87<br>0.87<br>0.87<br>1.93<br>0.64<br>1.07<br>0.64<br>1.07<br>0.64<br>0.65<br>5.74.33<br>0.64<br>1.07<br>0.65<br>5.18<br>9.76<br>0.65<br>5.18<br>0.9<br>5.3<br>0.9  | 0.06<br>1.12<br>2.28<br>2.58<br>0.06<br>0.87<br>0.87<br>0.87<br>0.87<br>0.87<br>0.64<br>1.07<br>0.64<br>0.65<br>9.77<br>0.65<br>9.77<br>0.65<br>9.76<br>0.65<br>9.76<br>0.65<br>0.65<br>0.9<br>7.18<br>1.07<br>0.65<br>8.28<br>8.21<br>8.21<br>8.21<br>8.21<br>8.21<br>8.22<br>8.21<br>8.21   | 0.06<br>1.12<br>2.28<br>2.58<br>9.77<br>0.06<br>1.69<br>1.69<br>1.07<br>0.64<br>1.07<br>0.64<br>1.07<br>0.64<br>0.65<br>9.76<br>9.76<br>9.76<br>9.76<br>9.76<br>9.76<br>9.76<br>9.76   | 0.06<br>1.12<br>2.28<br>2.58<br>9.77<br>0.06<br>1.69<br>1.93<br>0.64<br>1.07<br>0.65<br>9.76<br>9.76<br>9.76<br>9.76<br>9.76<br>9.76<br>9.76<br>9.76  
   |
|   | 2              | ő            | $^{2}O_{3}$  | eO                     | 1   | 4nO   | AnO<br>AgO   | AnO<br>AgO<br>CaO  | ∕InO<br>∕IgO<br>CaO<br>Va₂O  | MnO<br>MgO<br>CaO<br>Na₂O<br>K₂O  | MnO<br>MgO<br>CaO<br>Na2O<br>K2O<br>P2Os  | MnO<br>MgO<br>CaO<br>Na₂O<br>K₂O<br>E∱量   | MnO<br>MgO<br>CaO<br>K₂O<br>F₂Os<br>P₂Os<br>Total   | MnO<br>MgO<br>CaO<br>Na <sub>2</sub> O<br>K <sub>2</sub> O<br>P <sub>2</sub> O <sub>5</sub><br>Total<br>Total  | MnO<br>MgO<br>CaO<br>Na <sub>2</sub> O<br>P <sub>2</sub> O <sub>5</sub><br>Total<br>Total<br>AR  | MinO<br>MgO<br>CaO<br>Na <sub>2</sub> O<br>K <sub>2</sub> O<br>P <sub>2</sub> O,<br>P <sub>2</sub> O,<br>Total<br>a<br>RI<br>RI  | MinO<br>MgO<br>CaO<br>Na <sub>2</sub> O<br>K <sub>5</sub> O<br>K <sub>5</sub> O<br>R <sub>2</sub> O <sub>5</sub><br>Total<br>a<br>R<br>R<br>R<br>R<br>R<br>R<br>R<br>R<br>R<br>R   | MinO<br>MgO<br>CaO<br>Sa <sub>2</sub> O<br>K <sub>5</sub> O<br>K <sub>5</sub> O<br>Sa大量<br>Total<br>R1<br>R1<br>R1<br>R1<br>AIK   
   | MnO<br>MgO<br>CaO<br>CaO<br>Na <sub>2</sub> O<br>K <sub>5</sub> O<br>K <sub>5</sub> O<br>AlR<br>R1<br>R1<br>R1<br>R2<br>NKC  | MinO<br>MgO<br>CaO<br>CaO<br>CaO<br>F <sub>3</sub> O<br>K <sub>4</sub> O<br>P <sub>2</sub> O <sub>5</sub><br>AR<br>R1<br>R1<br>R1<br>R1<br>R1<br>R1<br>R1<br>MIK<br>C<br>MIKC  
   | MinO<br>MgO<br>CaO<br>CaO<br>CaO<br>CaO<br>P <sub>2</sub> O,<br>P <sub>2</sub> O,<br>P <sub>2</sub> O,<br>AR<br>R1<br>R1<br>R1<br>R1<br>R1<br>R1<br>R1<br>La<br>L1<br>La   | MinO<br>MgO<br>CaO<br>K <sub>3</sub> O<br>K <sub>3</sub> O<br>K <sub>4</sub> O<br>K <sub>3</sub> O<br>K <sub>3</sub> O<br>AlK<br>Rl<br>Rl<br>Rl<br>Rl<br>Rl<br>Rl<br>CaO<br>O<br>Ce<br>Ce<br>Ce<br>O<br>Ce<br>O<br>Ce<br>O<br>Ce<br>O<br>Ce<br>O<br>O<br>Na <sub>2</sub> O<br>CaO<br>O<br>SaO<br>CaO<br>O<br>SaO<br>CaO<br>O<br>SaO<br>CaO<br>O<br>SaO<br>CaO<br>O<br>SaO<br>CaO<br>O<br>SaO<br>CaO<br>O<br>SaO<br>CaO<br>O<br>SaO<br>CaO<br>O<br>SaO<br>CaO<br>O<br>SaO<br>CaO<br>O<br>SaO<br>CaO<br>O<br>SaO<br>CaO<br>O<br>SaO<br>CaO<br>O<br>SaO<br>CaO<br>O<br>SaO<br>CaO<br>O<br>SaO<br>CaO<br>O<br>SaO<br>CaO<br>O<br>SaO<br>CaO<br>O<br>SaO<br>CaO<br>O<br>SaO<br>CaO<br>O<br>SaO<br>CaO<br>CaO<br>CaO<br>CaO<br>CaO<br>CaO<br>CaO<br>CaO<br>CaO<br>C   | MinO<br>MgO<br>CaO<br>Sa <sub>2</sub> O<br>K <sub>5</sub> O<br>K <sub>5</sub> O<br>N <sub>2</sub> O <sub>5</sub><br>S<br>M <sub>2</sub> M <sub>2</sub><br>R<br>R<br>R<br>R<br>R<br>R<br>R<br>R<br>R<br>R<br>R<br>R<br>R<br>R<br>C<br>C<br>C<br>C<br>C  |
Mno<br>MgO<br>CaO<br>CaO<br>Na <sub>2</sub> O<br>K <sub>2</sub> O<br>K <sub>2</sub> O<br>Ma<br>R<br>R<br>R<br>R<br>R<br>R<br>R<br>R<br>R<br>R<br>R<br>R<br>R<br>R<br>R<br>R<br>R<br>R   | MnO<br>MgO<br>CaO<br>CaO<br>SaA<br>K <sub>2</sub> O<br>F <sub>2</sub> O<br>Ma <sub>2</sub> O<br>AR<br>AR<br>AR<br>R<br>AR<br>R<br>AR<br>R<br>Ca<br>AR<br>R<br>CaO<br>Co<br>S<br>Sm<br>Sm<br>Sm<br>Sm<br>Sm<br>Sm<br>Sm<br>Sm<br>Sm<br>Sm<br>Sm<br>Sm<br>S  | MnO<br>CaO<br>CaO<br>CaO<br>CaO<br>K <sub>2</sub> O<br>K <sub>2</sub> O<br>P <sub>2</sub> O <sub>5</sub><br>MAR<br>R1<br>R1<br>R1<br>R1<br>R2<br>R1<br>La<br>Pr<br>Ce<br>Ce<br>Ce<br>Ce<br>Ce<br>Ce<br>Ce<br>O<br>Sm<br>VNA2O<br>Ci<br>Sm<br>CaO<br>CaO<br>CaO<br>CaO<br>CaO<br>CaO<br>CaO<br>CaO<br>CaO<br>CaO   | MnO<br>MgO<br>CaO<br>CaO<br>CaO<br>CaO<br>F <sub>2</sub> O<br>S <sup>2</sup> A<br>AR<br>AR<br>AR<br>AR<br>AR<br>AR<br>AR<br>AR<br>AR<br>AR<br>AR<br>S<br>A<br>S<br>M<br>A<br>S<br>M<br>C<br>G<br>d<br>Gd<br>Gd  
  | MinO<br>MagO<br>CaO<br>CaO<br>CaO<br>CaO<br>CaO<br>P <sub>2</sub> O<br>MgC<br>MgC<br>M<br>M<br>M<br>M<br>M<br>M<br>M<br>M<br>M<br>M<br>M<br>M<br>M<br>M<br>M<br>M   | MinO<br>MgO<br>CaO<br>Sa <sub>2</sub> O<br>CaO<br>Na <sub>2</sub> O<br>Sa<br>Sa<br>AIK<br>AIK<br>Ca<br>AIK<br>Ca<br>AIK<br>Ca<br>AIK<br>Ca<br>CaO<br>CaO<br>CaO<br>CaO<br>CaO<br>CaO<br>CaO<br>CaO<br>CaO   | MnO<br>MgO<br>CaO<br>Sar<br>MgO<br>KsO<br>KsO<br>Sar<br>MgO<br>Ca<br>Eu<br>Fr<br>Ca<br>Ca<br>AIK<br>R<br>AIK<br>R<br>S<br>R<br>CaO<br>S<br>S<br>MgO<br>AIK<br>CaO<br>S<br>MgO<br>AIK<br>D<br>y<br>S<br>MgO<br>S<br>MgO<br>S<br>A<br>S<br>MgO<br>S<br>A<br>S<br>S<br>S<br>S<br>S<br>S<br>S<br>S<br>S<br>S<br>S<br>S<br>S<br>S<br>S<br>S<br>S  | Mno<br>MgO<br>CaO<br>CaO<br>CaO<br>F <sub>X</sub> O<br>K <sub>2</sub> O<br>K <sub>2</sub> O<br>MgO<br>Ca<br>Fr<br>Ca<br>R<br>AIK<br>Ca<br>AIK<br>Ca<br>AIK<br>Ca<br>D<br>S<br>M<br>Ho<br>D<br>D<br>D<br>D<br>D<br>D<br>D<br>D<br>D<br>S<br>M<br>Ho<br>CaO<br>D<br>S<br>S<br>CaO<br>D<br>S<br>S<br>S<br>S<br>S<br>S<br>S<br>S<br>S<br>S<br>S<br>S<br>S<br>S<br>S<br>S<br>S<br>S  
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图8 片麻状花岗岩A/CNK-A/NK图解 Fig.8 A/CNK-A/NK diagram of gneissic granite

(Sylvester, 1998; Barbarin, 1999), 而本文片麻状花 岗岩具有准铝质-弱过铝质岩石的特点,在Rb/Ba-Rb/Sr图解(图12)中,样品点构成了一定的线性关 系,而且所有样品都分布在砂页岩和杂砂岩源区, 表明其源区主要为砂页岩和杂砂岩。另外,CaO/ Na<sub>2</sub>O比值是判断源区成分的一个极其重要的指标, 当 CaO/Na<sub>2</sub>O 比值 < 0.5 时暗示源区为泥质岩,当 CaO/Na<sub>2</sub>O比值介于0.3~1.5时则源区为变杂砂岩或 火成岩,而目角闪岩部分熔融而成的偏中性熔体会 具有略高的CaO/Na<sub>2</sub>O 比值(Jung, 2007), 而本文片



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图 10 片麻状花岗岩 SiO<sub>2</sub>-Zr 图解 Fig. 10 SiO<sub>2</sub>-Zr diagram of gneissic granite

麻状花岗岩的 CaO/Na<sub>2</sub>O 比值介于 0.60~1.02(均大 于0.3),暗示源区为变杂砂岩。结合 C/MF-A/MF 源岩判别图中(图13),样品点也主要落入变质砂岩 部分熔融区。Harris and Inger(1992)的研究显示, 由泥质类源岩水饱和熔融产生的铝长英质岩浆具 有高 Sr / Ba 比值(0.5~1.6) 及正 Eu 异常, 而本文样 品的 Sr/Ba 比值(0.17~0.30)很低,具有负 Eu 异常, 显示非泥质类源岩特征。综上所述,认为片麻状花 岗岩是地壳变质砂岩部分熔融的产物。

#### 6.2 构造背景分析

青白口纪片麻状花岗岩常量元素具有高硅、铝、 钙碱性过铝质花岗岩特征,根据Barbarin(1999)的花



图 11 片麻状花岗岩球粒陨石标准化稀土元素配分图(a)和原始地幔标准化微量元素蛛网图(b) (标准化值据 Sun and McDonough, 1989)

Fig. 11 Chondrite-normalized REE patterns (a) and primitive mantle-normalized trace element patterns (b) of gneissic granite (after Sun and McDonough, 1989)





岗岩类分类,与大陆碰撞环境型花岗岩特征一致。微量元素蛛网图与典型陆-陆碰撞S型花岗岩(Pearce et al., 1984)特征相似,也与附近同时期同碰撞型花岗质片麻岩特征一致。在Pearce et al.(1984)定义的花岗岩类形成构造环境判别图上,大多数样品投点于同碰撞花岗岩区及其附近(图14)。在Hf-Rb/30-Ta×3三角判别图解上,大部分样品投到同碰撞和碰撞晚期-碰撞后花岗岩区域(图15)。综上所述,片状状花岗岩所形成的构造环境为同碰撞晚期。

区域上,阿尔金地区大量新元古代花岗岩物质 记录为限定该地区Rodinia超大陆汇聚时限提供了



Fig .13 AFM–CFM diagrams of gneissic granite (after Alther et al., 2000)

证据。Gehrels et al.(2003)在索尔库里斑状花岗岩 中获得锆石U-Pb同位素年龄为(922±6)Ma;王超等 (2006)在南阿尔金江尕勒萨依片麻状花岗岩中获 得(923±13)Ma的锆石U-Pb同位素年龄,地球化学 特征显示其具有地壳重熔型、同碰撞花岗岩的特 点,认为塔里木、柴达木以及祁连等陆块作为 Rodinia超大陆的一部分在新元古代早期曾发生过 汇聚碰撞作用;张建新等(2011)认为新元古代早期 (920~940 Ma)的构造热事件与塔里木(或晋宁)造 山作用有关,它普遍存在于塔里木盆地周缘的和南 中国地块(扬子克拉通)的变质基底岩石中,与

Rodinia 超级大陆汇聚相关:校培喜等(2014)的最新 研究成果表明,阿尔金地区其他反映Rodinia超大陆 汇聚的代表性的岩体还有库如克萨依片麻岩套 ((871±5.7)Ma)、清水泉南片麻状花岗岩((918±6.9) Ma和(922±8)Ma)和肖鲁克布拉克片麻状花岗岩 ((918±12)Ma 及(924±11)Ma)。王立社等(2015)在 阿尔金中段环形山二长花岗片麻岩中获得(928±9) Ma锆石U-Pb同位素年龄,显示S型花岗岩地球化 学特征,为同碰撞汇聚构造地质背景下地壳杂砂岩 部分熔融上侵形成。陈红杰等(2018)在科克萨依 新元古代花岗岩中获得锆石 U-Pb 同位素年龄为 (945±13)Ma,是古老地壳富长石贫黏土的变杂砂岩 部分熔融形成的S型花岗岩,是Rodinia 超级大陆汇 聚阶段碰撞造山环境下的产物。在研究区同碰撞 花岗岩还有亚干布阳片麻岩和盖里克片麻岩,均与 Rodinia超大陆汇聚有关,其中亚干布阳片麻岩的形 成年龄为(900.2±2.9)Ma,是地壳中沉积岩类部分熔

融的产物,形成于俯冲-同碰撞构造转折环境(李琦 等,2018),盖里克片麻岩的形成年龄为(886.5±5) Ma,是地壳中角闪岩相基性岩类(变玄武岩)部分熔 融的产物,形成于同碰撞构造环境(李琦等, 2015)。可见阿尔金地区新元古代早期碰撞型岩浆 岩形成时代集中在871~945 Ma,限定了Rodinia超 大陆汇聚碰撞时限。而本文片麻状花岗岩形成的 构造环境为同碰撞晚期,锆石U-Pb同位素年龄为 883 Ma,该年龄位于区域上Rodinia超大陆形成有 关的构造岩浆时限范围内,比附近亚干布阳片麻岩 和盖里克片麻岩形成时代稍晚。青白口纪亚干布 阳片麻岩、盖里克片麻岩和片麻状花岗岩,年代学 特征显示具有先后侵入就位的特点,构造环境也依 次为俯冲-同碰撞构造转折、同碰撞、同碰撞晚期,完 整记录了Rodinia超大陆汇聚同碰撞阶段的全过程。

前人研究表明,同碰撞阶段造山带地壳强烈的 缩短增厚过程中,导致深部地壳加压升温,地壳岩石





质

发生部分熔融形成过铝质花岗岩(Harris et al., 1986; Englang et al., 1992)。本文青白口纪片麻状花岗岩 与在阿中地块和柴达木地块陆陆同碰撞阶段地壳增 厚加压引起卷入地壳变质砂岩部分熔融有关,是罗 迪尼亚超大陆汇聚碰撞过程的响应(图16)。

### 6.3 对Rodinia超大陆汇聚时限的制约

罗迪尼亚(Rodinia)一词最早于1990年被引入 地学领域,是指一个10亿年前由大陆碰撞形成的全 球性的超大陆(Mcmenamin et al., 1990),随后以 Hoffman为代表的前寒武纪地质学家建立了新元古 代Rodinia超大陆复原图(Hoffman et al., 1991),在 此基础上李正祥等讨论了中国华北与华南在超大 陆中的位置,分别将华北和华南置于西伯利亚的两 侧,并认为宽坪和四堡运动在时代上与格林威尔运 动大致相当(Li et al., 1996)。我国新元古代早期汇 聚地质记录反映汇聚地质事件的年代多集中在0.8~ 1.0 Ga,在年轻造山带中识别前寒武纪时期的活动 带,特别是新元古代造山带对研究古陆块之间的汇 聚历史显得非常重要(陆松年, 2001)。

在新元古代早期,中国各主要克拉通地块(包括华夏地块、扬子地块、华北地块、阿拉善一祁连— 柴达木地块、塔里木地块)曾经通过晋宁期碰撞拼 合带发生过一次全面的多块体复杂拼贴(郭进京 等,1999)。在阿尔金、祁连、柴北缘和秦岭造山带 均存在新元古代早期的强烈构造-岩浆热事件,岩 浆岩具有同碰撞性质,与Rodinia超大陆形成有关, 年龄分别集中在 871~945 Ma、917~952 Ma、917~





943 Ma 和 911~978 Ma, 时限集中于 800~1000 Ma (校培喜等,2014),可见Rodinia超大陆汇聚事件在 中国西部基本同步,但各古陆块中岩浆响应的时间 存在差异,显示汇聚拼贴不是一蹴而就,而是逐步 完成的,且阿尔金地区新元古代早期洋壳俯冲、陆 块汇聚时限明显晚于柴北缘、祁连、秦岭地区。在 阿尔金邻区,柴达木地块与华北地块西部的阿拉善 地块首先汇聚碰撞,形成了柴北缘含柯石英榴辉 岩-花岗岩带(850~950 Ma),随后塔里木向东运移 并与柴达木斜接,斜接带为具有同剪切伟晶岩脉和 岩体(913 Ma)的韧性剪切带,即新元古代阿尔金断 裂,最后塔里木向东运移到华北边缘,与华北地块 一柴达木地块拼合,在柳园一带形成榴辉岩-花岗 岩带(860~880 Ma)(于海峰等,1999)。前人推测在 塔里木地块东南缘阿尔金断裂附近可能存在一条 晋宁期碰撞会聚带(郭进京等,1999)。在空间分布 上,阿尔金地区与Rodinia超大陆汇聚相关的江尕勒 萨依片麻状花岗岩、库如克萨依片麻岩套、清水泉 南片麻状花岗岩、肖鲁克布拉克片麻状花岗岩、亚 干布阳片麻岩、盖里克片麻岩和索尔库里斑状花岗 岩等岩体自西向东呈带状分布,构成了一条与 Rodinia超大陆汇聚相关的花岗岩带,也正是这次构 造事件使阿中地块和柴达木地块固结。

关于阿尔金造山带前寒武纪基底的属性,最新 资料表明其早前寒武纪地质演化与敦煌造山带、祁 连山、塔里木克和华北克拉通具有趋同性(王超, 2011;辛后田等,2011;Zhao et al.,2015;刘懿馨等, 2018),共同经历了古元古代哥伦比亚超大陆汇聚 和中元古代裂解的过程,表明这些地块在中元古代 之前与华北克拉通具有亲缘性。在新元古代时期,



Fig. 16 Model for the tectonic evolution during the early Qingbaikou period of the Altun

阿尔金的地质演化历史与柴达木、祁连、塔里木、秦 岭和扬子克拉通非常相似(王超,2011;张建新等, 2011;王立社,2015),而与敦煌造山带和华北克拉 通则有很大的不同,但它们均卷入了早古生代的造 山事件中,成为早古生代碰撞造山带的组成部分 (张建新等,2011),共同经历了新元古代Rodinia超 大陆汇聚和裂解的过程,表明这些地块在新元古代 与扬子克拉通具有亲缘性。

## 7 结 论

(1)在阿尔造山带亚干布阳一带发育一套片麻状 花岗岩,其岩性以片麻状黑云母花岗岩为主,还可见 少量片麻状黑云母正长花岗岩和片麻状二云正长花 岗岩,获得LA-ICP-MS 锆石U-Pb同位素年龄分别 为(883.0±3.3)Ma和(883.1±3.3)Ma,属青白口纪。

(2)岩石地球化学研究表明,片麻状花岗岩为 阿中地块和柴达木地块陆陆同碰撞阶段地壳增厚 加压引起卷入地壳变质砂岩部分熔融的产物,形成 于同碰撞晚期构造背景,是罗迪尼亚超大陆汇聚碰 撞过程的响应。

(3)结合区域地质背景,认为阿尔金地区新元 古代早期同碰撞型岩体的形成时代集中在871~945 Ma,限定了Rodinia超大陆汇聚时限,且在空间上具 有带状分布的特点,构成了一条重要的岩浆岩带, 为Rodinia超大陆汇聚碰撞的结果。

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#### References

- Alther R, Holl A, Hegner E. 2000. High-potassium, calc-alkaline Itype plutonism in the European Variscides: Northern Vosges (France) and northern Schwarzwald (Germany)[J]. Lithos, 50: 51–73.
- BarBarin B. 1999. A review of the relationships between granitoid types, their origins and their geodynamic environments[J]. Lithos, 46: 605–626.
- Barth M G, McDonough W F, Rndnick R I. 2000. Tracking the budget of Nb and Ta in the continental crust[J]. Chemical Geology, 165(3/ 4): 197–213.
- Bi Zhengjia, Zeng Zhongcheng, Zhang Kunkun, Liu Demin, Chen Ning, Zhao Jianglin, Li Qi, Li Dewei. 2016. Geochronology, geochemical characteristics and tectonic implications of the amphibolite from Paxialayidang area on the southern margin of

Altun terrain[J]. Geology in China, 43(4): 1149–1164 (in Chinese with English abstract).

- Cao Yuting, Liu Liang, Wang Chao, Chen DanLing and Zhang Anda. 2009. P-T path of Early Paleozoic pelitic high-pressure granulite from Danshuiquan area in Altyn Tagh[J]. Acta Petrologica Sinica, 25(9): 2260-2270 (in Chinese with English abstract).
- Cao Yuting, Liu Liang, Wang Chao, Yang Wenqiang, Zhu Xiaohui. 2010. Geochemical, zircon U–Pb dating and Hf isotope compositions studies for Tatelekebulake granite in South Altyn Tagh[J]. Acta Petrologica Sinica, 26(11): 3259–3271 (in Chinese with English abstract).
- Che Zicheng, Liu Liang, Liu Hongfu, Luo Jinhai. 1995. Found and its tectonic setting of the high– pressure metamorphic argillaceous rocks of Altyn mountain area[J]. Chinese Science Bulletin, 40(14): 1298–1300 (in Chinese with English abstract).
- Chen Hongjie, Wu Cailai, Lei Min, Guo Wenfeng, Zhang Xin, Zheng Kun, Gao dong, Wu Di. 2018. Petrogenesis and Implications for Neoproterozoic Granites in Kekesayi Area, South Altyn Continent[J]. Earth Science, 43(4): 1278–1292 (in Chinese with English abstract).
- Cui Junwen, Tang Zhemin, Deng Jinfu, Yue Yongjun, Meng Lingshun, Yu Qinfan. 1999. The Altyn Tagh Fracture System[M]. Beijing: Geological Publishing House, 137–213 (in Chinese with English abstract).
- Dong Guoan, Yang Huairen, Yang Hongyi, Liu Dunyi, Zhang Jianxin, Wan Yusheng. 2007. The zircon SHIMP U– Pb dating and its significance of the Precambrian basement, Qilian Tererance[J]. Chinese Science Bulletin, 52(13): 1572–1585 (in Chinese with English abstract).
- Dong Hongkai, Guo Jincheng, Chen Haiyan, Ti Zhenhai, Liu Guang, Liu Silin, Xue Pengyuan, Xing Weiwei. 2014. Evolution characteristics of Ordocician intrusive rock in Changshagou of Altun Region[J]. Northwestern Geology, 47(4): 73–87 (in Chinese with English abstract).
- Dostal J, Chatterjee A K. 2000. Contrasting behaviour of Nb/Ta and Zr/ Hf ratios in a peraluminous granitic pluton (Nova Scotia, Canada)[J]. Chemical Geology, 163(1):207–218.
- England P, Fort P L, Molnar P, Pêcher, A. 1992. Heat sources for Tertiary metamorphism and anatexis in the Annapurna– Manaslu Region central Nepal[J]. Journal of Geophysical Research Solid Earth, 97(B2):2107–2128.
- Gehrels G E, Yin A, Wang X F. 2003. Magmatic history of the northeastern Tibetan Plateau[J]. Journal of Geophysical Research, 108 (B9): 2423.
- Guo Jincheng, Xu Xuming, Chen Haiyan, Li Xian, Dong Hongkai, Ti Zhenhai. 2014. Zircon U–Pb Age and Geological Implications of Ultramafic Rocks in Changshagou, Altun Area, Xinjiang Province[J]. North Western Geology, 47(4):170–177(in Chinese with English abstract).

- Guo Jinjing, Zhao Fengqing, Li Huaikun. 1999. Jinningian collisional granite belt in the eastern sector of the Central Qilian massif and its implication[J]. Acta Geoscientica Sinica, 20(1): 10–15 (in Chinese with English abstract).
- Harris N B W, Pearce J A, Tindle A G. 1986. Geochemical characteristics of collision- zone magmatism[J]. Collision Tectonics, 19(5):67-81.
- Harris N B W, Inger S. 1992. Trace element modelling of pelitederived granites[J]. Contributions to Mineralogy & Petrology, 110 (1): 46–56.
- Hoffman P F. 1991. Did the breakout of laurentia turn gondwanaland inside-out?[J]. Science, 252(5011):1409.
- Jung S, Pfander J A. 2007. Source composition and melting temperatures of orogenic granitoids: constraints from CaO/Na<sub>2</sub>O, Al<sub>2</sub>O<sub>3</sub>/TiO<sub>2</sub> and accessory mineral saturation thermometry[J]. European Journal of Mineralogy, 19(6):859–870.
- Kang Lei, Liu Liang, Cao Yuting, Wang Chao, Yang Wenqiang, Liang Sha. 2013. Geochemistry, zircon U- Pb age and its geological significance of the gneissic granite from the eastern segment of the Tatelekebulake composite granite in the south Altyn Tagh[J]. Acta Petrologica Sinica, 29(9): 3039- 3048 (in Chinese with English abstract).
- Kang Lei, Xiao Peixi, Gao Xiaofeng, Xi Rengang, Yang Zaichao. 2016. Early Paleozoic Magamatism and Collision Orogenic Process of the South Altyn[J]. Acta Geologica Sinica, 90(10): 2527–2550 (in Chinese with English abstract).
- Li Z X, Zhang L, Powell C M. 1996. Positions of the East Asian cratons in the Neoproterozoic supercontinent Rodinia[J]. Journal of the Geological Society of Australia, 43(6):593–604.
- Li Qi, Zeng Zhongcheng, Chen Ning, Zhao Jianglin, Zhang Ruoyu, YI Pengfei, Gao Haifeng, Bi Zhengjia. 2015. Zircon U– Pb ages, geochemical characteristics and tectonic implications of Neoproterozoic gailike gneiss in the south Altyn Tagh[J]. Geoscience, 29(6): 1271–1283 (in Chinese with English abstract).
- Li Qi, Zeng Zhongcheng, Chen Ning, Zhang Ruoyu, Zhao Jianglin, Wang Tianyi, Yi Pengfei. 2018. Zircon U-Pb ages, geochemical characteristics and geological significance of Yaganbuyang gneiss in Qingbaikou period along the Altun orogenic belt[J]. Geological Bulletin of China, 37(4): 642–654 (in Chinese with English abstract).
- Li Xiangmin, Ma Zhongping, Sun Jiming, Xu Xueyi, Lei Yongxiao, Wang Lishe and Duan Xingxing. 2009. Characteristics and age study about the Yuemakeqi maficultramagic rock in the southern Altyn Fault[J]. Acta Petrologica Sinica, 25(4): 862– 872( in Chinese with English abstract).
- Lin Ciluan, Sun Yong, Chen Danling, Diwu Chunlong. 2006. Geochemistry and zircon LA–ICP MS dating of Iqe River granitic gneiss, northern margin of Qaidam Basin[J]. Geochimica, 35(5):

489-505( in Chinese with English abstract).

质

- Liu Xiaoming, Yuan H I, Bodo Hatten, Dorf Uünther, Chen Liang, Hu Shenghong. 2002. Analysis of 42 major and trace elements in glass standard reference materials by 193nm LA– ICP– MS[J]. Acta Petrologica Sinica,18 (3):408–418(in Chinese with English abstract).
- Liu Liang, Che Zicheng, Luo Jinhai, Wang Yan and Gao Zhangjian. 1996. Recognition and implication of eclogite in the western Altyn Mountains, Xinjiang[J]. Chinese Science Bulletin, 42(16): 931–934 (in Chinese with English abstract).
- Liu Liang, Che Zicheng and Wang Yan, Luo Jinhai, Wang Jianqi, Gao Zhangjian. 1998. The evidence of Sm- Nd isochron age for the Early Paleozoic ophiolite in Mangya area, Altun Mountains[J]. Chinese Science Bulletin, 43(8): 880-883(in Chinese with English abstract).
- Liu Liang, Zhang Anda, Chen Danling, Yang Jiaxi, Luo Jinhai, Wang Chao. 2007. Implications based on LA- ICP- MS zircon U- Pb ages of eclogite and its country rock from Jianggalesayi area, Altyn Tagh[J]. Earth Science Frontiers, 14(1): 98-107(in Chinese with English abstract).
- Liu Yixin, Sha Xin, Ma Zhen, Wang Jinrong. 2018. Geochemical characteristics and tectonic implication of the Shuanglong maficultramafic rocks in western section of the North Qilian[J]. Acta Petrologica Sinica, 34(2): 383–397(in Chinese with English abstract).
- Liu Yongshun, Yu Haifeng, Xin Houtian, Lu Songnian, Xiu Qunye, Li Quan. 2009. Tectonic units division and Precambrian significant geological events in Altyn Tagh Mountain, China[J]. Geological Bulletin of China, 28(10): 1430–1438(in Chinese with English abstract).
- Lu Fengxiang, Sang Longkang. 2002. Petrology[M]. Beijing: Geological Publishing House, 82–94(in Chinese).
- Lu S, Li H, Zhang C, Niu G H. 2008. Geological and geochronological evidence for the Precambrian evolution of the Tarim Craton and surrounding continental fragments[J]. Precambrian Research, 160 (1/2):94–107.
- Lu Songnian. 2001. From rodinia to gondwanaland supercontinents——Thinking about problems of researching Neoproterozoic supercontinents[J]. Earth Science Frontiers, 8(4): 441–448(in Chinese with English abstract).
- Lu Songnian. 2002. Preliminary Study of Precambrian Geology in the North Tibet–Qinghai Plateau[M]. Beijing: Geological Publishing House, 1–125(in Chinese).
- Lu Songnian, Chen Zhihong, Li Huaikun, Hao Guojie, Zhou Hongying, Xiang Zhenqun. 2004. Late Mesoproterozoic– Early Neoproterozoic evolution of the Qinling orogen[J]. Geological Bulletin of China, 23(2):107–112(in Chinese with English abstract).
- Mcmenaminm M A S, Mcmenaminm D L S. 1990. The Emergence of

Animals: The Canbrian Breakthrough[M]. New York: Columbia University Press, 1–12.

- Pearce J A, Harris N B W, Tindle A G. 1984. Trace element discrimination diagrams for the tectonic interpretation of granitic rocks[J]. Jour. Petrol., 25(4): 956–983.
- Pei Xianzhi, Jing Saping, Zhang Guowei, Liu Huibin, Li Zuochen, Li Wangye. 2007. Zircons LA- ICP- MS U- Pb dating of Neoproterozoic granitoid gneisses in the North Margin of West Qinling and geological implication[J]. Acta Geologica Sinica, 81 (6):772-786(in Chinese with English abstract).
- Rapp R P, Watson E B. 1995. Dehydration Melting of Metabasalt at 8– 32 kbar: Implications for Continental Growth and Crust–Mantle Recycling[J]. Journal of Petrology, 36(4):891–931.
- Rudnick R L, Fountain D M. 1995. Nature and composition of the continental crust: A lower crustal perspective[J]. Reviews Geophysics, 33(3): 267–309.
- Rutatto D. 2002. Zircon trace element geochemistry: Paritioning with garnet and the link between U– Pb ages and metamorphism[J]. Chemcal Geology, 184: 123–138.
- Sylvester P J. 1998. Post- collisional strongly peraluminous granites[J]. Lithos, 45(1/4):29-44.
- Sun S S, Mcdonough W F. 1989. Chemical and isotopic systematics of oceanic basalts: Implications for mantle composition and processes[J]. Geological Society London Special Publications, 1989, 42(1):313–345.
- Wan Yusheng, Xu Zhiqin, Yang Jingsui, Zhang Jianxin. 2003. The Precambrian High– grade Basement of the Qilian terrane and Neighboring Areas: Its ages and compositions[J]. Acta Geoscientica Sinica, 24(4):319–324(in Chinese with English abstract).
- Wang C, Liu L, Chen D L, Cao Y T. 2011. Petrology, geochemistry, geochronology, and metamorphic evolution of garnet peridotites from South Altyn Tagh UHP Terrane, Northwestern China: Records related to crustal slab subduction and exhumation history[C]// Dobrzhinetskaya L, Faryad W, Wallis S, Cuthbert S(eds.). Ultrahigh Pressure Metamorphism: 25 years after the discovery of metamorphic coesite and diamond, Elsvier, 541–576.
- Wang Chao, Liu Liang, Xiao Peixi, Cao Yuting, Yu Huiyang, Meert J G, Liang W T. 2014. Geochemical and geochronologic constraints for Paleozoic magmatism related to the orogenic collapse in the Qimantagh– South Altyn region, northwestern China[J]. Lithos, 202–203(4):1–20.
- Wang Chao, Liu Liang, Che Zicehng, Chen Danling, Zhang Anda, Luo Jinhai. 2006. U– Ph geochronology and tectonic setting of the granitic gneiss in Jianggaleisayi Eclogite Belt, the Southern Edge of Altyn Tagh[J]. Geological Journal of China Universities, 12(1): 74–82(in Chinese with English abstract).
- Wang Chao. 2011. Precambrian Tectonic of South Margin of Tarim Basin[D]. Xi' an: Northwest University, 1–137(in Chinese with English abstract).

- Wang Huichu, Yuan Guibang, Xin Houtian, Hao Guojie, Zhang Baohua, Wang Qinghai. 2004. Geological characteristic and age of the Iqe River Group- complex on the northern margin of the Qaidam basin[J]. Geological Bulletin of China, 23(4):314–321(in Chinese with English abstract).
- Wang Lishe, Zhang Wei, Duan Xingxing, Long Xiaoping, Ma Zhngping, Song Zhongbao, Sun Jiming. 2015. Isotopic age and genesis of the monzogranitic gneiss at the Huanxingshan in middle Altyn Tagh[J]. Acta Petrologica Sircica, 31(1): 119–132(in Chinese with English abstract).
- Wang Tao, Zhang Zong Qing, Wang Xiaoxia, Wang Yanbin, Zhang Chenli. 2005. Neoproterozoic collisional deformation in the core of the Qinling Orogen and its age constrained by zircon SHRIMP dating of strongly deformed syn– collisional granites and weakly deformed granitic veins[J]. Acta Geologica Sinica, 79(2):220–231 (in Chinese with English abstract).
- Wang Yong, Wang Bin, Chen Bailin, Wu Yu, Meng Lingtong, He Jiangtao, Chen Andong. 2017. New evidence of 2.0– 1.8 Ga granitic genesis Tarim plate belonging to Colombia supercontinent[J]. Geology in China, 44(2): 407–408(in Chinese with English abstract).
- Wang Zhonggang, Yu Xueyuan, Zhao Zhenhua. 1989. Rare Earth Element Geochemistry [M]. Beijing: Science Press. 223–224(in Chinese).
- Wu Cailai, Gao Yuanhong, Lei Min, Qin Haipeng, Liu Cunhua, Li Minze, Frost B R, Wooden J L. 2014. Zircon SHRIMP U– Pb dating, Lu– Hf isotopic characteristics and petrogenesis of the Palaeozoic granites in Mangya area, southern Altun, NW China[J]. Acta Petrologica Sinica, 30(8): 2297–2323 (in Chinese with English abstract).
- Wu Yuanbao, Zheng Yongfei. 2004. Zircon minerageny and its restriction on interpretion of U– Pb age[J]. Chinese Science Bulletin, 49(16): 1589–1604(in Chinese with English abstract).
- Xiao Peixi, Gao Xiaofeng, Hu Yunxu, Xie Congrui, Guo Lei, Xi Rengang, Dong Zengchan, Kang Lei. 2014. Study on Geological Background of Altyn Tagh–Eastern Kunlun Metallogenic Belt[M]. Beijing: Geological Publishing House, 54–55(in Chinese).
- Xin Houtian, Zhao Fengqing, Luo Zhaohua, Liu Yongsun, Wan Yusheng, Wang Shuqing. 2011. Deterimination of the Paleoproterozoic geochronological framework in aqtashtagh area in southeastern Tarim, China, and its geological significance[J]. Acta Geologica Sinica, 85(12): 1978–1993(in Chinese with English abstract).
- Xu Zhiqin, Yang Jingsui, Zhang Jianxin, Jiang Mei, Li Haibing, Cui Junwen.1999. A comparsion between the tectonic units on the two sides of the Altyn sinistral strike-slip fault and the mechanism of lithospheric shearing[J]. Acta Geologica Sinica, 73(3): 193-205(in Chinese with English abstract).
- Yu Haifeng, Lu Songnia, Mei Hualing, Zhao Fengqing, Li Huakun, Li Huimin. 1999. Characteristics of Neoproterozoic eclogite- granite

zones and deep level ductile shear zone in western China and their significance for continental reconstruction[J]. Acta Petrologica Sinica, 15(4):532–538(in Chinese with English abstract).

- Yuan Honglin, Wu Fuyuan, Gao Shan. 2003. Cenozoic intrusive laser probe zircon U– Pb and rare earth element composition analysis Determination in Northeast[J]. Science Bulletin, 48(14): 1511–1520.
- Zeng Zhongcheng, Biao Xiaowei, Zhao Jianglin, Liu Xiangdong, Zhang Ruoyu, Li Qi, He Yuanfang, Jian Kunkun. 2019. U– Pb geochronology of zircons from the volcanic rocks in Bingounan Formation, Southern Altyn Tagh: Implication for the Precambrian tectonic evolution [J]. Geological Review, 65(1): 103–118 (in Chinese with English abstract).
- Zhao Y, Sun Y, Yan J H, Diwu C R. 2015. The Archean– Paleoproterozoic crustal evolution in the Dunhuang region, NW China: Constraints from zircon U–Pb geochronology and in situ Hf isotopes[J]. Precambrian Research, 271: 83–97.
- Zhao Y, Sun Y, Diwu C R, Guo A L, Ao W H, Zhu T. 2016. The Dunhuang block is a Paleozoic orogenic belt and part of the Central Asian Orogenic Belt (CAOB), NW China[J]. Gondwana Research, 30:207–223.
- Zhang J X, Zhang Z M, Xu Z Q, Yang J S. 1999. The ages of U–Pb and Sm–Nd for eclogite from the western segment of Altyn Tagh tectonic belt——Evidence for existence of Caledonian orogenic root[J]. Chinese Science Bulletin, 44(24):2256–2259.
- Zhang J, Zhang Z, Xu Z, Yang J, Cui J. 2001. Petrology and geochronology of eclogites from the western segment of the Altyn Tagh, northwestern China[J]. Lithos, 56(2):187–206.
- Zhang Jianxin, Wan Yusheng, Meng Fancong, Yang Jingsui and Xu Zhiqin. 2003. Geochemistry, Sm- Nd andU- Pb isotope study of gneisses (schists) enclosing in the North Qaidam Mountains: Deeeply subducted Precambrian metamorphic basement? [J]Acta Petrologica Sinica, 19: 443–451 (in Chinesewith English abstract).
- Zhang Jianxin, Meng Fancong, Mattinson C G. 2007. Progress, Controversies and Challenge of Studies on South Altyn Tagh– North Qaidam HP/UHP Metamorphic Belt[J]. Geological Journal of China Universities, 75(2): 186–197 (in Chinesewith English abstract).
- Zhang Jianxin, Li Huaikun, Meng Fancong, Xiang Zhenqun, Yu Shengyao, Li Jinping. 2011. Polyphase tectonothermal events recorded in "metamorphic basement" from the Altyn Tagh, the southeastern margin of the Tarim basin, western China: Constraint from U–Pb zircon geochronology[J]. Acta Petrologica Sinica, 27 (1): 23–46 (in Chinesewith English abstract).
- Zhang Ruoyu, Zeng Zhongcheng, Zhe Weipeng, Chen Ning, Zhao Jianglin, Li Qi, Wang Qinwei, Rao Jingwen. 2016. LA-ICP-MS zircon U- Pb dating, geochemical features and their geological implications of paxialayidang plutons on the southern margin of Altyn Tagh[J]. Geological Review, 62(5): 1283-1299(in Chinese with English abstract).
- Zhang Ruoyu, Zeng Zhongcheng, Chen Ning, Li Qi, Wang Tianyi,

Zhao Jianglin. 2018. The discovery of Middle– Late Ordovician syenogranite on the southern margin of Altun orogenic belt and its geological significance[J]. Geological Bulletin of China, 37(4): 545–558( in Chinesewith English abstract).

Zhao Zhenhua, Wang Zhonggang, Chu Tianren, Masuda A. 1991. The REE, isotopic composition of O, Pb, Sr, Nd and diagenetic model of granitoids in Altai region[J]. Bulletin of Mineralogy, Petrolog and Geochemistry, 24(3): 176–178 (in Chinese).

#### 附中文参考文献

- 毕政家,曾忠诚,张昆昆,曹同礼,刘德民,陈宁,赵江林,李琦,李德 威.2016. 阿尔金南缘帕夏拉依档沟斜长角闪岩年代学、地球化 学及其构造意义[J]. 中国地质, 43(4):1149-1164.
- 曹玉亭, 刘良, 王超, 陈丹玲, 张安达. 2009. 阿尔金淡水泉早古生代 泥质高压麻粒岩及其 P-T 演化轨迹[J]. 岩石学报, 25(9): 2260-2270.
- 曹玉亭,刘良,王超,杨文强,朱小辉.2010.阿尔金南缘塔特勒克布 拉克花岗岩的地球化学特征、锆石 U-Pb 定年及 Hf 同位素组 成[J]. 岩石学报,26(11): 3259-3271.
- 车自成, 刘良, 刘洪福, 罗金海. 1995. 阿尔金山地区高压变质泥质岩 石的发现及其产出环境[J]. 科学通报, 40(14): 1298-1300.
- 陈红杰, 吴才来, 雷敏, 郭文峰, 张昕, 郑坤, 高栋, 吴迪. 2018. 南阿尔 金陆块科克萨依新元古代花岗岩成因及地质意义[J]. 地球科学, 43(4): 1278-1292.
- 崔军文,唐哲民,邓晋福,岳永军,孟令顺,余钦范.1999. 阿尔金断裂 系[M].北京:地质出版社,137-213.
- 董国安,杨怀仁,杨宏仪,刘敦一,张建新,万渝生等.2007.祁连地块 前寒武纪基底锆石 SHRIMP U-Pb 年代学及其地质意义[J].科学 通报,52(13);1572-1585.
- 董洪凯,郭金城,陈海燕,提振海,刘广,刘思林,薛鹏远,邢伟伟. 2014. 新疆阿尔金地区长沙沟一带奥陶纪侵入岩及其演化特 征[J]. 西北地质,47(4):73-87.
- 郭金城, 徐旭明, 陈海燕, 李先, 董洪凯, 提振海. 2014. 新疆阿尔金长 沙沟超镁铁质岩锆石 U-Pb 年龄及其地质意义[J]. 西北地质, 47 (4):170-177.
- 郭进京,赵风清,李怀坤.1999. 中祁连东段晋宁期碰撞型花岗岩及 其地质意义[J]. 地球学报, 20(1): 10-15.
- 康磊,刘良,曹玉亭,王超,杨文强,梁莎.2013.阿尔金南缘塔特勒克 布拉克复式花岗质岩体东段片麻状花岗岩的地球化学特征、锆 石U-Pb定年及其地质意义[J].岩石学报,29(9):3039-3048.
- 康磊,校培喜,高晓峰,奚仁刚,杨再朝.2016.阿尔金南缘早古生代 岩浆作用及碰撞造山过程[J].地质学报,90(10):2527-2550.
- 李琦,曾忠诚,陈宁,赵江林,张若愚,易鹏飞,高海峰,毕政家.2015. 阿尔金南缘新元古代盖里克片麻岩年代学、地球化学特征及其 构造意义[J].现代地质,29(6):1271-1283.
- 李琦,曾忠诚,陈宁,张若愚,赵江林,王天毅,易鹏飞.2018. 阿尔金 造山带青白口纪亚干布阳片麻岩年龄、地球化学特征及其地质 意义[J].地质通报,37(4):642-654.
- 李向民,马中平,孙吉明,徐学义,雷永孝,王立社,段星星.2009.阿 尔金断裂南缘约马克其镁铁-超镁铁岩的性质和年代学研究[J].

#### 第47卷 第3期 曾忠诚等:阿尔金造山带青白口纪片麻状花岗岩的厘定及对 Rodinia 超大陆汇聚时限的制约 589

岩石学报, 25(4): 862-872.

- 林慈銮, 孙勇, 陈丹玲, 第五春荣. 2006. 柴北缘鱼卡河花岗质片麻岩 的地球化学特征和锆石 LA-ICP-MS 定年[J]. 地球化学, 35(5): 489-505.
- 柳小明,高山,袁洪林, Bodo Hatten, Dorf Uünther, 陈亮, 胡圣红. 2002. 193nm LA-ICP-MS 对国际地质标准参考物质中42 种主 量和微量元素的分析[J]. 岩石学报, 18(3):408-418.
- 刘良,车自成,罗金海,王焰,高章鉴.1996. 阿尔金山西段榴辉岩的 确定及其地质意义[J].科学通报,42(11):931-934.
- 刘良,车自成,王焰,罗金海,王建其,高章鉴.1998. 阿尔金茫崖地区 早古生代蛇绿岩的 Sm-Nd等时线年龄证据[J]. 科学通报,43(8): 880-883.
- 刘良,张安达,陈丹玲,杨家喜,罗金海,王超.2007.阿尔金江尕勒萨 依榴辉岩和围岩锆石 LA-ICP-MS 微区原位定年及其地质意 义[J].地学前缘,14(1):98-107.
- 刘懿馨, 沙鑫, 马蓁, 王金荣. 2018. 北祁连西段双龙镁铁质--超镁铁 质岩地球化学特征及构造意义[J]. 岩石学报, 34(2).: 383-397.
- 刘永顺,于海峰,辛后田,陆松年,修群业,李铨.2009. 阿尔金山地区 构造单元划分和前寒武纪重要地质事件[J]. 地质通报, 28(10): 1430-1438.
- 路凤香, 桑隆康. 2002. 岩石学[M]. 北京: 地质出版社, 82-94.
- 陆松年.2001.从罗迪尼亚到冈瓦纳超大陆——对新元古代超大陆 研究几个问题的思考[J].地学前缘,8(4):441-448.
- 陆松年.2002. 青藏高原北部前寒武纪地质初探[M]. 北京: 地质出版 社, 1-125.
- 陆松年, 陈志宏, 李怀坤, 郝国杰, 周红英, 相振群. 2004. 秦岭造山带 中一新元古代(早期)地质演化[J]. 地质通报,23(2):107-112.
- 裴先治,丁仨平,张国伟,刘会彬,李佐臣,李王晔.2007. 西秦岭北缘 新元古代花岗质片麻岩的LA-ICP-MS 锆石 U-Pb 年龄及其地 质意义[J]. 地质学报, 81(6):772-786.
- 万渝生,许志琴,杨经绥,张建新.2003.祁连造山带及邻区前寒武纪 深变质基底的时代和组成[J].地球学报,24(4):319-324.
- 王超,刘良,车自成,陈丹玲,张安达,罗金海.2006.阿尔金南缘榴辉 岩带中花岗片麻岩的时代及构造环境探讨[J].高校地质学报,12 (1):74-82.
- 王超.2011. 塔里木盆地南缘前寒武纪地质演化[D]. 西安: 西北大学 博士学位论文, 1-137.
- 王惠初,袁桂邦,辛后田,郝国杰,张宝华,王青海.2004.柴达木盆地 北缘鱼卡河岩群的地质特征和时代[J].地质通报,23(4):314-321.
- 王立社, 张巍, 段星星, 龙晓平, 马中平, 宋忠宝, 孙吉明. 2015. 阿尔 金环形山花岗片麻岩同位素年龄及成因研究[J]. 岩石学报, 31 (1);119-132.
- 王涛,张宗清,王晓霞,王彦斌,张成立.2005.秦岭造山带核部新元 古代碰撞变形及其时代——强变形同碰撞花岗岩与弱变形脉体 锆石 SHRIMP 年龄限定[J].地质学报,79(2):220-231.

- 王永, 王斌, 陈柏林, 吴玉, 孟令通, 何江涛, 陈安东. 2017. 塔里木板 块归属 Colombia 超大陆的新证据:来自北阿尔金地区 2.0~1.8 Ga 花岗质片麻岩体[J]. 中国地质, 44(2): 407-408.
- 王中刚, 于学元, 赵振华. 1989. 稀土元素地球化学[M]. 北京:科学出版社, 223-224.
- 吴才来, 部源红, 雷敏, 秦海鹏, 刘春花, 李名则, Frost B R, Wooden J L. 2014. 南阿尔金茫崖地区花岗岩类锆石 SHRIMP U-Pb 定年、 Lu-Hf同位素特征及岩石成因[J]. 岩石学报, 30(8): 2297-2323.
- 吴元保,郑永飞. 2004. 锆石成因矿物学研究及其对 U-Pb 年龄解释 的制约[J]. 科学通报, 49(16):1589-1604.
- 校培喜, 高晓峰, 胡云绪, 谢从瑞, 过磊, 奚仁刚, 董增产, 康磊. 2014. 阿尔金一东昆仑西段成矿带地质背景研究[M]. 北京: 地质出版 社, 54-55.
- 辛后田,赵凤清,罗照华,刘永顺,万渝生,王树庆.2011. 塔里木盆地 东南缘阿克塔什塔格地区古元古代精细年代格架的确定及其地 质意义[J]. 地质学报, 85(12): 1978-1993.
- 许志琴,杨经绥,张建新,姜枚,李海兵,崔军文.1999. 阿尔金断裂两 侧构造单元的对比及岩石圈剪切机制[J]. 地质学报,73(3):193-205.
- 于海峰,陆松年,梅华林,赵风清,李怀坤,李惠民.1999.中国西部新 元古代榴辉岩—花岗岩带和深层次韧性剪切带特征及其大陆再 造意义[J],岩石学报,15(4):532-538.
- 曾忠诚,边小卫,赵江林,刘向东,张若愚,李琦,何元方,菅坤坤. 2019. 阿尔金南缘冰沟南组火山岩锆石U-Pb年龄及其前寒武纪 构造演化意义[J]. 地质论评, 65(1): 103-118.
- 张建新,万渝生,孟繁聪,杨经绥,许志琴. 2003. 柴北缘夹榴辉岩的片 麻岩(片岩)地球化学、Sm-Nd和U-Pb同位素研究——深俯冲的 前寒武纪变质基底? [J]岩石学报, 19(3): 443-451
- 张建新, 孟繁聪, Mattinson C G. 2007. 南阿尔金一柴北缘高压-超高 压变质带研究进展、问题及挑战[J]. 高校地质学报, 13(3):526-545.
- 张建新, 李怀坤, 孟繁聪, 相振群, 于胜尧, 李金平. 2011. 塔里木盆地 东南缘(阿尔金山)"变质基底"记录的多期构造热事件: 锆石 U-Pb 年代学的制约[J]. 岩石学报. 27(1): 23-46.
- 张若愚,曾忠诚,朱伟鹏,陈宁,赵江林,李琦,王秦伟,饶静文.2016. 阿尔金造山带帕夏拉依档岩体锆石U-Pb年代学、地球化学特征 及地质意义[J].地质论评,62(5):1283-1299.
- 张若愚,曾忠诚,陈宁,李琦,王天毅.赵江林.2018. 阿尔金造山带南 缘中一晚奥陶世正长花岗岩的发现及其地质意义[J]. 地质通报, 37(4):545-558.
- 赵振华, 王中刚, 雏天人, 增田彰正. 1991. 阿尔泰花岗岩类型与成岩 模型的REE及O、Pb、Sr、Nd同位素组成依据[J]. 矿物岩石地球化 学通报, 24(3): 176-178.